THE

ELECTRICAL REVIEW.

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ELECTRICAL REVIEW.

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THE

UNIVERSAL ELECTRICAL DIRECTORY

(J. A. BERLY'S).

1907 Edition

TO APPEAR IN JANUARY.

Advertisements, new names and corrections to existing entries should be sent in at once.

1906—1907.

THE Old Year has closed during a period of remarkable industrial activity and commercial prosperity; we sincerely trust that the New Year will maintain this happy condition, and that the electrical trades will secure a fair share of the benefits to be derived therefrom. With few exceptions, we fear, electrical firms during the past year by no means realised the advantages of the revival in trade, although many of their works were fully employed, and this untoward result must be ascribed, to a great extent, to the severe competition experienced in almost all branches of the industry. While it is very easy to depress prices by "cutting," it is far from an easy matter to restore them to a healthy level, at which reasonable profits can be made. Now, however, when our foreign rivals are fully occupied, the opportunity has arisen for the trade to resume its normal condition, and we hope that the year 1907 will be the first of a prolonged series of "fat" years to make up for the leanness of their predecessors.

The fact that an improvement has already set in, and shows every sign of continuance, is clearly indicated by our monthly tables of exports and imports of electrical machinery; a review of these for the past two years shows that whereas the average value of the former for the 12 months ending in January last was £112,381, the average for the ten months ending in November, 1906, was £134,897; similarly the figures for the imports during the same periods were £122,224 and £146,520 respectively, and the returns for the closing months of the year show a further remarkable increase.

Turning to the more notable events of the past year, the principal feature in the lighting business perhaps was the flood of metallic-filament lamp inventions, though some of the lamps themselves are not yet on the market. Regarding these, we feel that they inaugurate a new era in electric lighting, and will go far towards counteracting the improvements in gas lighting which have taken place in recent times. The price of electrical energy has been reduced almost everywhere during the year, and before long it will be available in most of our leading towns at little more than 3d. per unit. We deal with the development of the commercial branch of electricity supply in a leaderette.

In traction, the opening of two new "tubes" and of the Great Western electric section mark the year; single-phase systems are in progress on the Brighton Co.'s Railway and the Midland Railway, but little seems to have been done as yet. The Kingsway subway and the Embankment tramways represent the most striking developments of the L.C.C. systems. Several surface-contact tramways are apparently on the verge of completion, but for some mysterious reason they "hang fire."

The Metropolitan District Railway electrification has not given such satisfactory results as were hoped for, but this

appears to be the fault not at all of the electrical working, but rather of the earlier management, or mismanagement, of the undertaking.

The sad fate of the London Power Bills calls for a passing lament; how the new L.C.C. and other London Supply Schemes will fare this year remains to be seen. The Kent Power Co. is nearly ready for work; the South Wales undertaking is passing through the throes of regeneration, and the North Wales scheme—our only great water-power undertaking—has successfully commenced operations. The general development of the use of electricity for motive power augurs well for the future; already the large generating stations at Manchester and Salford, for example, both of which, a few years ago, were alleged to be far too big, are loaded nearly to the limit of their capacity. Sufficient has been said of the Victoria Falls scheme for the present; we sum up the situation elsewhere in this issue.

The event of the year in telegraphy was the Wireless Telegraph Conference, followed by the interesting announcement of Mr. V. Poulsen's improved system. The benefit of the underground telegraph cables, now completed as far as Glasgow, was amply felt during the recent snowstorms, though some important towns, not yet connected with the cables, were temporarily isolated; it is to be hoped that the underground system will be extended with all possible speed.

The visit of the foreign *confrères* of the Institution of Electrical Engineers in itself made the year memorable, and its perfect success gratified all British electrical men.

We have not touched upon more than a fraction of the many interesting events of the year, but, perhaps, we have said sufficient to show that 1906 was a notable year in the history of electrical engineering in this country; and we hope that 1907 will not only equal its predecessor's record but will far surpass it.

Electricity Supply Development.

Our readers are already familiar with the very valuable work that has been accomplished on the other side of the Atlantic by the Co-operative Electrical Development Association of Cleveland, Ohio. The prize essays already published have, doubtless, done much to work up a more enthusiastic and enterprising spirit among those whose calling it is to push the sale of electricity. The Association has now announced an offer of $2,600 in prizes for an electrical "solicitor's" (canvasser's) handbook. It is desired that there shall be available a handbook which will be instructive and stimulating to representatives of supply authorities, contractors or others who are canvassing the public for the sale of electricity for light, heat and power. For the "Light" Section there are to be three prizes, valued at $500, $300 and $200 respectively. For the "Power" Section, three prizes of similar value; and for "Heat" the awards will be valued at $300, $200 and $100. The handbooks submitted will be judged by a committee appointed by the president of the National Electric Light Association.

The special series of articles on the subject of commercial development of electricity supply, written by Mr. R. Borlase Matthews, was concluded in our last issue; but it is our intention frequently to devote space to further contributions, in which we hope that valuable advice will be given to aid managers and engineers in their development schemes. To arouse intelligent interest in the matter among councillors and directors is very necessary in the first place, and prejudice will have to be cleared away. A Chairman of a Municipal Electric Lighting Committee, during the course of a discussion on the incomes *per cap.* of various electric lighting stations, remarked, when a particularly good instance was brought to his attention, "Ah! but they have been established 15 years." This, however, is just the point of a new business-getting campaign: a properly conducted aggressive movement of this nature will accomplish results in a year or two that otherwise would not be obtained in many years under the more ordinary methods, therefore it behoves the supply authorities to investigate these methods and to make it their business to increase business—to increase their loads by every honest, logical means, taking advantage of every modern commercial method that will serve their purpose, so that they may provide the inhabitants of their territory with that service which will add so much to the brightness and healthiness of their surroundings, and to the relief of domestic and industrial labour.

Co-Partnership.

The twenty-first annual report of the Labour Co-partnership Association, issued last month, covers a period of 14 months, ending August 31st, 1906. The report is a distinctly interesting document, which shows the slow but steady progress which the system known as co-partnership is making in this country. It would appear that the number of co-partnership "productive" societies, which was 15 in 1883, rose to 77 in 1893, and had reached 124 by the end of 1895. These societies have a joint capital of nearly £2,000,000, do a trade of £3,700,000 per annum, make a profit of nearly £190,000 (also a loss of £7,395), and distribute among their employés a substantial amount in addition to paying wages at the standard rate. Most prominent among the British enterprises conducted on co-partnership lines are, naturally, the five gas companies which have adopted the system. Quoted in the order of their importance as profit-sharing companies, the gas undertakings are the South Metropolitan (which adopted the principle of co-partnership in 1889); the Commercial, 1901; the South Suburban, 1893; the Newport, 1900; and the Chester Gas Works, 1901. During the year ending June last these five companies allotted over £53,000 amongst 7,200 workmen, while the approximate value of the shares held by the employés amounted to over £368,000.

The report also contains an account of the proceedings of the Co-operative Congress held at Birmingham, to which the Co-Partnership Association sent a large number of delegates, and the half-yearly meeting of the Association at Batley, where Mr. T. C. Taylor, M.P., made an interesting speech, and Mr. J. D. Stuart-Sim read a paper on the ownership of capital by working-classes. From this it would seem that including all friendly, co-operative, building, &c., societies, the Railway, Trustee, and Post Office Savings Banks, the total amount of money held by workmen amounts to £402,256,600. The last annual meeting of the Association was held at the end of October, when an address was delivered by Sir George Livesey, chairman of the South Metropolitan Gas Co. In his speech, Sir George spoke in a very favourable manner of the co-partnership principle, somewhat more favourable indeed, than he spoke to his shareholders at the last meeting of the company itself (as already mentioned in the Electrical Review). The president of Labour Co-Partnership Association is now Prof. S. J. Chapman, M.A., Dean of the Faculty of Commerce, Manchester University; Mr. H. T. Eve, K.C., M.P., is the hon. legal adviser; Mr. Aneurin Williams, hon. treasurer, and Mr. Henry Vivian, M.P., secretary.

ELECTRIC MEASUREMENT OF BRIEF INTERVALS OF TIME.

In experiments in physics, when we want to measure the duration of a phenomenon which continues for a very short time, we generally determine the space traversed by a moving body, the conditions of movement of which are known. For example, we should utilise the fall of a body which in its descent, encounters first one lever which starts the operation, and then a second which makes it cease. An oscillating pendulum which sets in motion props, placed at different points of its path, has also been used for the same purpose. Finally, and most frequently, the production and stoppage of the phenomenon are controlled by electric relays.

This method of procedure amounts to measuring a space or a length, and deducing from this the time by the mathematical law supposed known, of a moving body. The method is necessarily liable to error owing to the difficulty of estimating space with precision, of knowing exactly the law of motion, of being able to take into exact account the delay in the working of the electric relays. We may further add that the result is only obtainable at the cost of calculations of a long and complicated nature.

We may find a more convenient and exact method by having recourse to an electric phenomenon. It is known, indeed, that electrical quantities depend on mechanical units, and certain expressions of these quantities are uniquely related to fundamental units. To come to details, the product, C R, of a capacity and a resistance, whatever be the system of electric units adopted, is analogous to a time. This quantity occurs in a very simple fashion in the expression of a charge of a condenser, closed on a resistance R.

If E be the electromotive force of a battery, the charging current is given by the formula—

$$I = \frac{E}{R} e^{-\frac{t}{CR}}$$

where e is the base of the Napierian logarithms ($e = 2{\cdot}718$). At the time t the charge in the condenser is—

$$Q = \int I\,dt = C E \left(1 - e^{-\frac{t}{CR}}\right),$$

or, if Q be taken as the complete charge—

$$Q = Q_0 \left(1 - e^{-\frac{t}{CR}}\right).$$

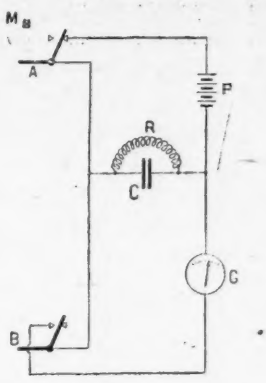
The same formulæ apply to the discharge. If after having charged the condenser we discharge it, the charge remaining at the end of the time t will be $Q_1 = Q_0 - Q = Q_0 e^{-\frac{t}{CR}}$.

By measuring this remaining charge and comparing it with the total charge, the knowledge of the ratio $\frac{Q_1}{Q_0}$ will give the quantity whence we deduce the value of the time t during which the condenser is discharged. It will suffice, then, to think of a plan which would enable the condenser to be discharged during the whole period of the phenomenon, for the measure of the remaining charge to give immediately the amount of the time.

This is how we should arrange the experiment. Two levers, A and B, which the moving body releases in its fall, are connected to one another and to one side of the condenser C shunted by the resistance R. The other side of the condenser is connected to the negative terminal of the ballistic galvanometer G and to the pole of a battery P. The second pole of P is united to the abutment stop of A, and the positive terminal of the galvanometer G to the impact stop of B.

The moving body M in falling sets A in motion. At that moment the connection of the condenser and the battery will be broken and the condenser will discharge across the resistance R. When the moving body meets B the lever will fall on its impact stop, permitting the condenser in this way to discharge across the galvanometer G. In order that, during this discharge, we may neglect the quantity of electricity which continues to pass across the resistance R, it will be adequate to make the resistance of the galvanometer sufficiently small with respect to the latter, a condition which it is always easy to realise.

The time t thus determined is that which elapses until the moment when the lever B meets its impact stop. If it is desired to measure the time of working of the lever itself—say, of A for example—the same method is easily applied. We would connect to A the first face of the condenser, the battery to the abutment stop and the galvanometer to the impact stop. It is easy to imagine the arrangements we



should make in order to take into account the working of the other parts if they intervened during the progress of the phenomena under consideration. From the following table all calculations can be readily made :—

$\frac{t}{CR}$	$e^{-\frac{t}{CR}}$	$\frac{t}{CR}$	$e^{-\frac{t}{CR}}$
0·00	1·00	1·00	0·36
0·01	0·99	1·20	0·30
0·05	0·95	1·40	0·25
0·10	0·91	1·60	0·20
0·15	0·86	1·80	0·16
0·20	0·82	2·00	0·134
0·30	0·74	2·50	0·081
0·40	0·66	3·00	0·049
0·50	0·60	3·50	0·030
0·60	0·54	4·00	0·018
0·70	0·49	4·50	0·011
0·80	0·44	5·00	0·007
0·90	0·40	6·00	0·002

We have employed this method to determine the time which the lever of the discharging switch takes to pass from the abutment stop to the impact stop. It is interesting to know this time, for if we measure a badly insulated capacity—for example, the capacity of an aerial line during the passing of the lever—the line is discharging itself in consequence of its bad insulation, and the capacity we observe is less than the actual capacity. If we know the time during which the line has thus lost its charge, it becomes easy to estimate the quantity of electricity which has disappeared, and to take account of it.

We have varied the resistance of the shunt within very wide limits, and we have always found the same figures. The capacity of the condenser was about 1 microfarad.

R ohms.	Charge left.	$\frac{t}{CR}$	t in seconds.
800	0·25	1·40	0·0011
1,000	0·34	1·07	0·0011
2,000	0·54	0·60	0·0012
3,000	0·69	0·37	0·0011
5,000	0·78	0·24	0·0012
8,000	0·86	0·14	0·0011
10,000	0·88	0·12	0·0012
100,000	0·987	0·013	0·0013

We see by the agreement of the results obtained that the method is good. It enables us to measure without difficulty ten-thousandths of a second. We may also remark that the lever of the discharging switch always works under similar conditions.

The combinations to which this method lends itself are most varied. We have applied it, among others, to determine the speed with which the lever of the discharging switch moves, of which we have spoken above.

To this end we varied the distance which separates the two stops by turning the screw, which constitutes one of them, to

a known degree. A complete turn would correspond to 1 mm. We then found the following figures :—

Turns of the screw.	Time in seconds.
¼	0·0032
½	0·0065
¾	0·0090
1	0·0105
1¼	0·0120
1½	0·0135
1¾	0·0150
2	0·0162
2¼	0·0175
2½	0·0185

The speed, increased at first, then became uniform, and finally slackened. The distance of 1 mm. (a turn of the screw) is traversed in about six-thousandths of a second, which corresponds to an average speed of 600 m. an hour.

In the same way that we have been able to determine a time by knowing a capacity and a resistance, we can likewise determine a capacity by knowing a time and a resistance. The value of resistances being very exactly known in absolute units, and the time being determined with great approximation by means of a seconds pendulum, the use of the method we have just indicated enables us to measure a capacity in absolute units, and that in terms of quantities that can be evaluated with great precision. We shall publish later on the very interesting results to which it leads with reference to the standardising of condensers, but it will now be readily understood why it affords a means of attaining an accuracy not obtainable by other modes. We know, indeed, that capacity is a quantity sufficiently badly defined, which depends on the phenomena which accompany the charge and which are especially the phenomena of the residual charge. The methods generally employed do not give results which agree, because the conditions employed are different. Here, on the contrary, we arrange the duration of the charge, the duration of the discharge and the epoch at which C is measured. Thus one can either study how a condenser varies with the different elements which influence its capacity, or determine C very accurately for the conditions under which it is generally used. — Devaux-Charbonnel (*L'Electricien*).

[The foregoing method was originally devised by Mr. Robt. Sabine, and was fully described by him in the Electrical Review (then the Telegraphic Journal) of May 15th, 1876.—Eds. E.R.]

LONDON'S ELECTRICAL SUPPLY.

The question of a supply of electricity for London has unfortunately degenerated into a matter more of politics than of engineering, and there is some danger of the more important features of the situation being overlooked. A short *résumé* of the history of the struggle may therefore be opportune.

The provisional order system of supplying electricity has, on the whole, answered fairly well in provincial towns, but in London the number of separate districts is so great that it has led to a needless multiplication of areas, systems and stations; the fault is increased by the fact that municipal undertakings are strictly confined within their own boundaries, while any attempt at combination by the companies or boroughs has been prevented by the "association" clause in their orders, which has done much to hinder electrical progress in London. This was fully brought out in the Parliamentary struggle of 1905.

Many of the companies in London are subject to competition; other safeguards for the consumer are :—

(*a*) The London companies are all purchasable by the Borough Councils in 1931; and

(*b*) The prices charged are subject to periodical revision by the Board of Trade, although this has not been resorted to in practice.

On the other hand, the companies were compensated for their limited tenure by being allowed to charge practically any prices the consumer would pay, and to pay any dividends which could be earned; the latter have recently been fairly good, and justifiably so in view of the risks and small dividends of early days.

It had already been realised in 1889 that this procedure by provisional orders was not sufficient to deal with power supply, and following the report of Lord Cross's Committee, numerous private "power Acts" have been granted in the leading industrial districts. This report has been closely adhered to by Parliament and emphasised :—

1. The growing importance of electric power for industrial purposes.

2. The advantages of generating electricity on a much large scale than had been necessary for lighting; and

3. The unsuitability of making power undertakings purchaseable by the local authorities,

while it also showed that the supply of electricity wholesale or in bulk and the retail supply for power-users were distinct questions. Power Acts, therefore, are of two kinds, those dealing with bulk supply and those dealing with retail power supply also; but neither kind of Power Act has ever yet been granted to a local authority.

The unsuccessful London County Council Bills of 1902 and 1903, about which some confusion has arisen, were in no sense Power Bills, neither did they deal with the retail supply of electricity, being mainly framed with the object of facilitating the purchase of the companies' undertakings by the Borough Councils and ultimately by the County Council.

In 1904 the first Power Bill affecting London itself was introduced, the East London and Lower Thames Power Bill. It was framed upon the same lines as the score of Power Acts already granted, and dealt with "bulk" supply and retail power supply, empowering the Board of Trade to permit a direct retail supply for power purposes to be given to the consumer where desirable. The Bill, however, was rejected, as the promoters were unable to satisfy the House of Commons' Committee that they had adequate financial support.

Attention had now been drawn, however, to London as a field for power supply, and in 1905 eight important measures were promoted, all dealing with bulk supply and some with power supply also. Some were promoted by existing companies, some by the Boroughs, one by the East London and Lower Thames Co., and one by a new body of promoters, several of whom had been identified with a successful power scheme on the Tyne, who sought to be incorporated as the Administrative County of London and District Electric Power Co. All the Bills were referred to a strong Committee of the House of Lords under Lord Camperdown, which gave them the closest attention for nearly six weeks. Broadly speaking, the issues at stake were :—

1. Were the existing undertakings (with or without new powers) able to supply London's electrical needs? If not,

2. Was it in the public interest that a new company should be created for the purpose?

The most important schemes of the existing companies divided London into three parts, the Metropolitan Co. taking the West, the Charing Cross Co. taking the East, and the City Co. taking the Southern portion. The Borough Councils' scheme was not taken very seriously, and the struggle gradually resolved itself in a fight between the existing undertakings and the Administrative Co. The latter contended that the large number and small average size of the existing generating stations in London prevented them producing at a price which would enable electricity to replace all other forms of power in London. They held that the establishment of a central system with two or three large generating stations in London was the way, and the only way, to bring the latter about. The existing companies declared the newcomers' estimates of London's power requirements and the possibility of securing the business to be much exaggerated, and they further felt that as pioneers who had sunk their capital during the risky stages they were entitled to reap the advantage of later developments. In several cases both companies and local authorities were able to show that so far as existing conditions allowed power supply was being energetically pushed. However, the Administrative and the Metropolitan Co.'s Bills were passed by the Lords, the area of the latter Bill being cut out of the area sought by the former. By the House of Commons' Committee, under Sir James Kitson, a number of alterations were made in the Administrative Bill at the instance of the County Council which offered the scheme the strongest opposition; these included :—

1. A purchase clause on the lines suggested by the

London County Council enabling the undertaking to be bought in 42 years' time, the terms of purchase being settled in the Bill.

2. A sliding scale of price and dividend on the lines suggested by the Council by which no dividend could be paid if the average price exceeded 1d. per unit.

3. An obligation upon the company to supply all consumers at a price not exceeding a certain maximum schedule (¾d. for an eight-hour day.)

4. A periodical revision of this schedule by the Board of Trade at the instance of the County Council or any local body.

But although the Bill passed the second reading and Committee stage of the Commons, the supporters of the Council in the House itself were able to block the Bill and prevent it reaching third reading before the close of the session.

The net result of the 1905 proceedings, therefore, was to draw public attention to the advantages of electrical production on a large scale, and the necessity for some improvement in the existing means of supplying London with electric *power*. None of these schemes really touched *lighting*, which, of course, forms four-fifths of the business in London to-day.

In the 1906 session the County Council appeared upon the scene as a promoter; the existing companies also brought forward a scheme for removing the antiquated restrictions against "association," while the Administrative Co. promoters re-introduced their Bill. The County Council measure did not deal with power supply, but was made a "permissive" Bill only, authorising the Council to supply electricity "in bulk" throughout greater London. A new scheme was also brought forward with a good financial backing by a body known as the Additional Power Co., which proposed to generate current at St Neots, and transmit it to London. This was, however, refused a second reading by the House of Commons. The other Bills were referred to a special Hybrid Committee, the main issue being whether the wholesale production and sale of electricity in London should be in the hands of the County Council or private enterprise, or of a combination of the two. So far as bulk supply to the Borough Councils went, the County Council made out a good case, but owing in large measure to the warnings of the Council's own Finance Committee, which pointed out the speculative nature of such an enterprise, and the difficulty of a municipal body carrying on a scheme of this kind which differs in so many respects from the ordinary lighting supplies which have been so successfully carried out in the provinces, the County Council Bill was rejected. The Committee produced a special report, in which they suggested that the Council would be wise to consider the relative advantages of taking the whole of the risk itself, and of sharing them with private enterprise, as its own Finance Committee had already suggested. The Committee recommended the suspension of all the other Bills in order that the Council might make a fourth and final attempt to secure Parliamentary powers, failing which private enterprise should be empowered to carry out the work. The Committee gave a most inadequate hearing to the scheme proposed by the existing companies.

The Council's present scheme is the outcome of this report, but it is a less likely scheme even than the last. The difficulty under which the Council labours is this. Its third Bill (1905) mainly failed, not because of its numerous technical faults, but because it did not go far enough; because, in the opinion of the Board of Trade, it did not ensure a cheap supply to the consumer, nor, in the opinion of the Council's Finance Committee, a satisfactory return to the ratepayer; on the other hand, "permissive" though it was, it was opposed by 19 boroughs and practically all the outside authorities, an opposition which, it appears likely, will be still stronger against the present scheme. Three strong Parliamentary Committees have been satisfied that this problem cannot be solved by a bulk supply scheme only. The Council has, therefore, included in its present Bill the "Bristol" clause, which empowers the Board of Trade to authorise a direct supply to the power-user in certain circumstances. The Council also goes further, and proposes to acquire *in toto* the undertakings of the Borough Councils immediately at their nominal value, and those of the companies as soon as possible, and such of the outside authorities undertakings as it can get by agreement. Thus, the scheme is no longer a "bulk" or even a power scheme, but an attempt to combine the supply of electricity for lighting, power and traction, and concentrate it in the Council's own hands; until it gets the companies' undertakings into its hands it proposes to compete with them under the above clause, with results which are obvious. So far as the combination of electricity supply goes for all purposes, the scheme looks rather plausible were it not for its speculative nature and commercial risks and the grave doubt as to whether the time is ripe for such a vast proposal. For it must be remembered that this is a ten times bigger affair than any proposal ever yet put forward by the companies which confined themselves to the supply of electricity in bulk where desired and of power where required, a comparatively small part of the present business in London. This being so it is not surprising that the Council's Finance Committee has once again warned the Council against the measure which must arouse the warm opposition of the borough councils and companies. Something must, however, be done. The matter has dragged on quite long enough, and the delay has caused enormous expense to the ratepayer and other promoters, and has had a disturbing effect on the stability of electrical investments and has benefited no one except the legal fraternity. In the meantime the consumer and his interests appear to receive more attention than those of the child in the education controversy, and the power-user is inclined to join with the engineer in crying "a plague upon your politics." For whatever the result of the March elections, no one who has studied the question considers that there is the slightest likelihood of Parliament passing the present measure of the County Council unless the Bill makes obligatory the leasing of the undertaking, or in some other way co-operates with private enterprise.

Probably the wiser tactics, from a purely electioneering point of view, would be a definite announcement that the Council, while controlling the supply of electricity, was prepared to leave the provision of the capital in whole or in part, and the entire operation, to private enterprise.

GAS TURBINES.

THE problem of converting an intermittent pressure into a continuous one, has hitherto baffled the would-be inventors of gas turbines. The possibility of separate combustion of the fuel must have suggested itself to many as a solution of the difficulty, but, so far, the details made known as to the practical application of this idea are extremely meagre. A paper on "Experiments with a Constant-Pressure Generator for Gas Turbines," in the *Zeitschrift für das Turbinenwesen*, is, therefore, of interest, as quoting from an actual example, although the account of the experiments does not enter much into detail, and a clear description of the machinery is not given; this, probably, is too much to expect until the experiments have enabled the apparatus to be designed on a commercial scale. The author notes the need of a means of precise regulation for governing the temperature of the gas used. Two are practicable: cooling by admission of air, and the utilisation of the superfluous heat to generate steam, which is passed with the gas through the turbine. The first is the more efficient, especially when the gas comes from a distance. In large gas engines, combustion taking place in the cylinder, this heat is taken up by the sides and piston, &c., and assists the efficiency. With a mixture of steam and products of combustion passing through the turbine, the specific heat of the gas and steam is no greater, and the efficiency is poorer.

A generator was designed to try the two methods. Compressed air at 165 lb. was passed through a pipe, and kerosine was used as fuel. Two methods of starting were employed. By the one, after opening the valve, a small quantity of gasoline was introduced into the combustion chamber, and lighted with a spill. After burning for a second, a kerosine receptacle was connected, and a large clear flame produced. When the flame had burnt for a few minutes, a pressure of 10

atmospheres (150 lb.) was produced in the generator and the gas flowed through the open valve.

The other method of starting was to have an air pressure of 72 lb. and admit the heating oil slowly, lighting it by means of smouldering tinder in the combustion chamber. After warming the combustion chamber, the gasoline was drawn off and the kerosine admitted.

When pressure is attained in the generator, the flame is observed through an observation window, and regulated to a clear white colour.

The author concludes from the experiments that, as to obtaining the necessary pressure and temperature, no serious difficulties need be anticipated. The principal difficulties appear to arise from the uncertainty of the start and deterioration of the lining of the combustion chamber. These difficulties, the author believes, are easily reducible. With the experimental plant, trouble was occasioned by the breaking off of the chamber lining and the fluctuating temperature of the gas.

It appears that these experiments (which were conducted in the Experimental Engineering Department of the Illinois University, at Garland) demonstrated the possibility of working a gas-driven turbine by means of a separate generator; but that the latter was found defective in mechanical detail, and that therefore only short runs could be performed (two hours). In the absence of a description of the apparatus, this is all that can be gathered from the paper.

THE FUTURE TELEGRAPH SYSTEM.

By WILLIAM J. WHITE.

An applied science attains maturity in three stages. First, the original conception by the inventor; then the laboratory development, in the course of which the idea assumes a concrete and practical shape; and, last stage of all, the commercial and financial stage when the original form is generally adapted and improved beyond recognition.

The modern generators driven by the gigantic forces of Niagara bear little resemblance to the early machines of Gramme and others, and the steam turbine of to-day would not at first be recognised as belonging to the same family as its ancestor—the steam engine of James Watt.

With modern telegraphy, however, improvements on the original designs have, in many cases, been surprisingly small. The original Morse code is still with us, and the Morse key and sounder are still, for all practical purposes, the same as when first designed. No substitute has, so far, been found superior to the porcelain insulator, and copper wire still holds the field as the medium of communication.

Signs are not wanting, however, that a critical period in the history of telegraphy has now been reached. The requirements of commercial life to-day are such that the older system is barely able to cope with them. The essential feature of a successful telegraph system has been well expressed by Mr. Gavey:—"Most telegraphic administrations have considered the ideal system to be a manual system . . . . in which the messages are brought up to the instrument at the forwarding station and dispatched over the wires, while at the receiving station they are written off direct, packed in envelopes and sent out without any intervening operations."

To ensure this being done on all occasions is, from financial considerations alone, out of the question. A long telegraph line represents a considerable capital outlay for plant, and a large annual payment for maintenance. The cost of skilled operators at salaries of from 20s. to 60s. per week has also to be taken into account, and the establishment charge must not be neglected. Against this, there is the cost per telegram from which the outlay is to be recouped. In fixing this charge, competition from the telephone system and quick postal deliveries has to be considered, and prevents any excessive rates being charged.

Progress obviously will lie in two directions. First, the maximum output of the plant must be secured; secondly, the cost of operating the service must be reduced if possible. The two directions are to a certain extent antagonistic, and to secure one advantage may mean that the other to some extent must be sacrificed. A compromise, therefore, is necessary, and in arriving at a result, the total cost per message must be the deciding factor.

Before proceeding to assume the dangerous *rôle* of prophet, it would be as well to review the work which has already been done in the two directions mentioned above: we shall then see what data are available for estimating the place of telegraphy in the commercial life of the future.

The most ambitious attempt made to increase the capacity output of the plant has up to the present been the introduction of the Delany multiplex system. In this system, the wire, by means of an arm revolving over segments, was given to each of four operators in turn at each end of the wire, and as duplex working could be adopted, it was theoretically possible to apportion eight operators to each end of the wire. The system was tried in this country for some time, but the numerous difficulties inherent in the system caused it to be abandoned.

The limit which has so far been reached successfully is quadruplex. Traffic requirements, which fluctuate to a great degree, do not always warrant full quadruplex working, and a system which has been found to be of considerable utility in this country is that known as the "split quadruplex" system, in which three stations—say, X, Y and Z—can be so connected that X can work duplex to Z on the A side relayed, and also duplex to Y on the B side, while *at the same time* Y can work duplex to Z on the B side—duplex working being thus practicable between each of the three stations.

The mention of traffic requirements brings us to the second factor of the situation—the cost of operation of the service. This point is of enormous importance in the economy of the telegraph service. In order that the exact cost of transmitting and delivering a message may be ascertained, it is necessary to keep in view many widely diverging factors. When the individual values of these factors have been compiled, curves must be plotted in order to determine the particular point where the maximum efficiency and economy lie.

At the outset we are confronted with difficulties, and it becomes necessary to divide the work into three stages, viz., cheap lines, lines of moderate cost, and lines whose erection necessitates considerable outlay of capital. In the first case, the payment of the operators would, with our present plant, bear a very large proportion in comparison with the capital cost of plant; on long lines, on the other hand, the determining factor may be the capital cost of the plant involved.

The case may be illustrated by a numerical example. Assuming the value of the line to be 100, and the cost of the operator as 5, it will be more economical to employ as many operators on the wire as the working capacity of the wire will admit. The disadvantage is in the delay inseparable from this method of working. If the value of the line is only equivalent to 5, no advantage will be gained by multiplying the operators, a more efficient service being secured by multiplying the lines.

High speed Wheatstone working and machine telegraphy generally, in which several men are punching for transmission, can only be profitable when applied to circuits of some considerable cost.

On lines of this character, then, machine telegraphy will be the keynote of the future. Rather we might say it is the keynote of the present, as the machine system is practically passing through the third stage—that of commercial development.

Modern machine telegraphy may be divided into three classes, typified by three systems. First, the Hughes; second, the Baudot; third, the Murray, and its adaptation, the Murray Creed. A fourth class might be added, comprising photo-printing telegraph systems, these systems having a certain vogue on the Continent.

The Hughes system is now firmly established. It has held its own by reason of its simplicity and the fact that the electrical portion of the apparatus is reduced almost to a minimum. The type wheels at each end of the circuit are made to revolve in synchronism by a mechanical contrivance, assisted by a movement which comes into operation every time a letter is recorded. The

more efficient the operator, therefore, the more efficient the system. Signals are sent from a keyboard similar to that of a pianoforte, the letters and punctuation marks being engraved on the keys. Depression of a key sends a current to line, so that the paper slip at the distant end is brought into contact with the revolving type wheel at the right instant for the letter to be printed. The force necessary to raise the paper is furnished by the driving gear, the printing action being controlled by the current sent from the transmitting station. This current at the same time also rectifies any small deviation from synchronism in the printing wheels at each station.

The Murray system is somewhat more intricate. An operator at the transmitter station punches a slip by operating on a typewriter keyboard. Depressing a key causes a combination of five punches to pierce holes in a paper slip. The slip is put through a special form of automatic transmitter, and a receiving perforator at the distant station is by an ingenious synchronous device operated so as to produce a tape punched with holes in a manner similar to that at the transmitting station. The received punched slip is then passed through a "printer," which, acting on the principle of a Jacquard loom, operates a typewriter, and prints the received message in type-written characters.

The Baudot is, perhaps, one of the most important of machine telegraphs in use at the present time. Briefly, the system may be explained thus. If there are four operators at each end of a single line, the line is by an ingenious distributing arrangement given to each operator in turn, while he sends a signal. As soon as the signal is completed, the line is given to the next operator. The signal that the line is about to be connected to his instrument is announced to the operator by means of a click in a telephone receiver placed in a convenient position. Synchronism between the transmitting and receiving distributors is of course essential, in order that the line may be connected to the proper pair of operators at the same instant.

From the foregoing description it will be noticed that there is one feature which is common to the three systems. They all require some kind of synchronising or isochronising device for their operation. Synchronism is at all times difficult to secure, and harder still to maintain. It is this difficulty of maintaining synchronism that spells failure to so many projected type-printing systems, and the ideal type-printing telegraph for which we are all waiting will, let us hope, be free from any synchronising or isochronising device.

Another defect of modern type-printing telegraphs is the difficulty which they all possess of maintaining communication when the apparatus is out of order. It is not enough that the apparatus should be perfect, it must be "perfection, with 33 per cent. margin!" That is to say, it must work even when not quite in order, and under unfavourable conditions. This is where the old system still holds ground. If conditions are not favourable to quadruplex working, duplex working is usually possible. Should duplex working prove unsatisfactory, one can revert to simplex, and if simplex cannot be worked, there is no telegraph system, except wireless, that can.

With machine telegraphy the case is different. The slightest thing wrong with the synchronising arrangements is usually sufficient to throw the whole system out of order. In order, therefore, to control the working, it is in practice found necessary to have a Morse signalling set, which can be connected to the line at will, available for localising breakdowns and issuing instructions. The important advantage claimed for machine telegraphy, namely, that it dispenses with the need for specially-trained operators, is thus nullified.

A second factor operating against the universal adoption of machine telegraphy is that of cost. Murray and Baudot apparatus is from 10 to 20 times as expensive as Morse apparatus, and the annual cost of maintenance is also much less with the older systems. This at once puts machine telegraphy out of court on all lines where the capital cost of the apparatus is at all to be compared with the cost of the lines.

The machine telegraph of the future will overcome as far as possible these disadvantages. It must be simple. The ideal is a typewriter keyboard operated by any person who can use a typewriter at one end of the line; an instrument at the other end recording the message in Roman characters. The Hughes and Baudot systems record their messages in Roman characters on a paper slip, the Murray in type-written characters in page form. The latter is preferable. The Baudot suffers from the disadvantage of requiring specially trained operators to work the peculiar keyboard used, but this defect could be overcome, and a typewriter keyboard substituted. The Hughes keyboard is cumbersome, and the key has to be held down for intervals, depending on the position of the chariot. In practice, however, the operator can depress two or more keys together and take as full advantage as possible of each revolution of the chariot.

What we are waiting for, then, is the simple system in which the operator types away at one end of the cheap line and the message comes out type-written in page form at the receiving station. For lines which are more costly, the system must be capable of being duplexed or quadruplexed, while for the most expensive lines, we want a telegraph type-printing system capable of being actuated at a speed representing the maximum capacity of the line. In each case the total cost per message must be such as to enable the system to compete with all others, whether telegraphic or telephonic.

There are also minor developments which will probably come into being in connection with commercial work. The big business houses will have their private telegraph lines to the nearest post office. A typewriter telegraph instrument being placed in the merchant's office, a typist will type messages previously dictated, and these will be received on a printing machine at the post office. The dropping of an indicator will warn the operator that a message is waiting; it will be taken from the receiver and dispatched to its destination without delay. If the message is an order to another merchant, the latter will in a few minutes see it signalled to his office, and going to the receiving instrument, will simply abstract it, and acknowledge it in a similar way. No fuss and worry. No waiting to get on the telephone, with the loss of time and temper. Everything working smoothly and quietly, awaiting the approach of the millennium!

CORRESPONDENCE.

Letters received by us after **5 p.m. on Tuesday** *cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.*

The Absorption of the Atmosphere for Light of Different Wave-Lengths.

It will not really surprise "Sol" if I refuse to regard gold as a transparent body. I may be wrong—but I require to be convinced that I am wrong—in contending that green light only passes through gold leaf, because gold leaf is porous and not transparent, and the pores in the gold leaf *interfere* with the passage of wave lengths other than green wave lengths.

"Sol" bases all his theory on the assumption that the air is uniformly filled with fine particles of a size comparable with the length of blue light waves, and, if this is so, I ask "Sol" to explain why these small particles cannot be detected under the microscope.

When Tyndall enunciated his theories, in a not too definite manner, the microscope was not capable of resolving such fine divisions of matter as it is to-day.

"Sol" does not understand my explanation as to why the sun appears red when near the horizon, and he professes to be startled that my explanation involves recognition of the fact that there is an excess of red in sunlight, but why this should startle him I am at a loss to comprehend; neither can I comprehend why he considers that his theories are supported by the fact that distant objects appear too light in a photograph, as it must be apparent to the meanest intelligence that this fact could equally well be used to support my argument.

Both "Sol" and I agree that the atmosphere *reflects* blue light better than any other colour, and I say that, this being so, the atmosphere must necessarily *transmit* blue light better than any other colour as well.

"Sol" differs from me on this latter point, and I again ask him to give one single example of a transparent body, other than air, which forms an exception to the rule that transparent bodies best transmit the colour that they best reflect; but his example must be of a transparent body, and not an example such as gold, which is, of course, opaque in a very high degree.

C. Orme Bastian.

London, N.W., *December 27th*, 1906.

An Overloaded Set.

I am under the impression that I am overworked, and would like you to give your opinion, if not any of your many subscribers.

I am engineer at a factory, employing between 800 and 900 hands. The plant consists of three high-speed engines and dynamos, two boilers, with pumps, &c., storage battery, 20 motors, ranging from 6 to 20 B.H.P., about 2,000 lights, incandescent and Nernst lamps, electric irons, telephones and bells, and from two to three miles of steam piping, for heating and other purposes.

To run the above plant, which is running at nearly full load every day without any spare plant, there is myself, a youth and a stoker. I have to do my own repairs after 6 p.m. at nights and at week-ends; you may guess this amounts to a lot, as two-thirds of the plant has being running for about eight years.

And still my employers are not satisfied!

Tired.

[No wonder our correspondent is "tired;" he has our sincere sympathy!—Eds E.R.]

Colonial Appointments.

In your issue of November 23rd last, I notice an advertisement for an electrical engineer to take charge of the lighting and power plant at His Majesty's Mint in Calcutta. Is there any possible chance whatever, of men in British Colonies being able to apply for such positions? We do not receive the home papers until (in most cases) the final date for sending in applications is long past, and, in ordinary common-sense, I think that men in the Colonies (provided they received their education at Home) should be more fitted for Colonial work, than men sent out direct from London, who have probably never been across the sea in their lives, and know as much about Colonial workings and customs as the proverbial "donkey does about the Psalms."

Presuming that such an appointment as the above must be filled by a certain date, would not it be possible for such advertisements to be cabled to various Colonies (even to this semi-civilised country of South Africa), in order that English engineers, resident in such Colonies, might have a chance of applying? Influence, we know is 99·99 per cent. of the battle in most municipal and company positions, but I do not think that this applies to Government appointments.

Charles Dudding.

Cape Town, S.A.,
December 11th, 1906.

Turbo-Generator Tests.

My attention has just been drawn to a paragraph in your issue of November 30th, page 877, under the heading "British Turbo-Generators," in which you refer to some recent tests made by Messrs. Dick, Kerr & Co., to determine whether turbine-driven machinery could be operated with no greater rise in temperature than ordinary low-speed machines. The wording of this paragraph would lead one to believe that these were the first tests of this kind which had been made.

I should like to point out that last winter a complete set of tests were made on a 1,500-KW. turbo-generator manufactured by us, and installed at the Wandsworth station of the County of London Electric Supply Co. These tests were made under the direction of Mr. C. P. Sparks, the company's chief engineer, and showed a maximum temperature rise at full load of 75° F. on the core and 61° F. on the stator windings.

Many tests made by us during the last two years have demonstrated that it is quite feasible to build turbo-generators which will have as good constants as regards both regulation and heating as ordinary engine-driven sets, and I think that the paragraph in question was rather misleading in intimating that Messrs. Dick, Kerr & Co. were the first to demonstrate this fact.

J. L. Conover,
Managing Engineer,
The British Thomson-Houston Co., Ltd.

Rugby, *December 28th*, 1906.

[We are always ready—and glad—to publish interesting tests when we receive particulars of them.—Eds. E.R.]

Metallic Filament Lamps for Street Lighting.

I was pleased to see that a station engineer was anxiously waiting for a larger type of lamp than is at present on the market, as I have been waiting for a similar lamp also; we are just now about tired of the small 25-C.P. tantalum lamps for street lighting. We have had a number of streets fitted up with four tantalums on each post, but are giving them up owing to the very heavy cost of renewals, as we have not had more than an average of 300 hours' burning per lamp. I think it would be a boon to station engineers both for street lighting and private lighting if a lamp of the tantalum type could be made at a reasonable cost, of the size that "Station Engineer" suggests, and whilst upon the subject is it not a pity that tantalum lamps should be such an absurd price, as people will not pay 5s. 6d. for a renewal, when they can get a gas renewal for 6d.?

I think it is about time that makers tried to give us a cheaper and more reliable lamp than at present, otherwise it is not very promising for the electrical industry.

We have people who are giving up the use of the light, with current at 3d. per unit, and the consumer using tantalum lamps, and this with gas at 2s. 5d. per 1,000 ft., so that it is evident that electricity is not so much sought after as it ought to be.

Another Station Engineer.

[Single lamps cost 2s. 9d. each, list price.—Eds. E.R.]

I think your correspondent last week, who is hoping for the early placing on the market of a suitable 100-C.P. lamp for street lighting, is voicing the wish of all central station engineers.

I have found by experience that it is not satisfactory to have all lighting power from one burner per post, and two lamps in series are of course no better.

I may say that we have not a single gas lamp left in Whitby for street lighting; the lighting is carried out with ½-ampere Nernst lamps, and two 8-C.P. lamps, and the complaints that are made when one of the Nernst burners fails and leaves the post unlit are not by any means without justification. I have no fault to find with Nernst burners of the ½-ampere A type, having obtained very good results.

With regard to the candle-power mentioned I quite agree that 100-C.P. lamps are required; when all allowance is made for dew, dust, &c., the 100-C.P. lamp will appear more like 50 C.P. What is wanted is a reliable high-efficiency filament lamp of, say, 50 C.P. to burn direct on voltages up to 250; then if two of these are placed on each post, the district lighted by the post will not be put in total darkness by the failure of a filament.

I am replacing all single-burner lanterns with two-light fittings of Messrs. Oliver & Co.'s make; the fitting is named "Whitby" in their list, although I am not aware of anybody in this town or bearing the name designing it; but it is a fitting that is worth sampling for side street lighting.

I shall be pleased to see more correspondence on this interesting question. When one considers the miles of side

streets that are still lit with gas, I do not think station engineers can do better than state their views.

L. H. King.

Electricity Department, Whitby,
December 24th, 1906.

I have read the letter in your issue of December 28th from "Tantalised." As we have had a great deal of trouble with some of these lamps owing to their failing to make good contact in the ordinary lamp-holders, I should be glad to know whether others amongst your readers have experienced similar trouble. The contacts on the cap of the lamp seem to be very badly fitted, and the blob of solder sticking out from the contact plate is an unsatisfactory feature. As far as the filament itself is concerned, we find the lamps satisfactory.

Chief Engineer.

In reply to the letter by "Tantalised," perhaps it will interest him to learn that tantalum lamps are doing well for street lighting in Cambuslang, running two in series on a voltage of 250. Over 400 lamps are employed—two on a post—and the average life is well over 800 hours. Nearly all our consumers use some tantalum lamps, and three shops and two large houses are wired throughout for tantalum. In every case they have given complete satisfaction, and two or three shopkeepers have given notice that their wiring is to be altered all over their shops for tantalum lamps. If "Tantalised" will take the simple precaution of pairing his lamps, he will find that they are in every way as reliable as the makers claim them to be—provided that the voltage of the supply is not bad, and alternating current is not used. Tantalum lamps blacken, but (unlike carbon lamps) when black the candle power does not fall off or the consumption increase.

The remark about a tantalum lamp being an over-run one is nonsense. For instance, sometimes a filament breaks and joins again, thus cutting out a good deal of the filament. These broken filament lamps have, as a rule, a life of over 300 hours, although they get very black. Again, one of my consumers put a 125-volt tantalum lamp into a holder wired for 250 volts. This lamp had burnt for nearly half-an-hour when a wiring contractor, being attracted by the brilliant light, went into the shop and stopped this interesting experiment! I have not gone quite so far as the above, but burn two tantalum lamps in the station on a voltage of 265, and find that they stand this voltage better than a carbon-filament lamp. These facts have satisfied me that the tantalum lamp is not just an over-run one as "Tantalised" suggests. It is not nice to see the use of tantalum and other economical lamps discouraged when we have the gas to fight. Let "Tantalised" compare ordinary carbon-filament lamps with inverted gas, and he will see that it is high time that the carbon filament was done away with altogether, if electric light is not to suffer in the future. Flame arcs, mercury vapour, metal filament and Nernst lamps are all able *in their proper places* to compete in a successful manner with gas. However, with the exception of the first two, a more economical lamp than these will have to be produced before the gas people will stop bragging.

In conclusion, I would point out to "Tantalised" that the demand for tantalum lamps is at present far in excess of the supply, which fact seems to point out that we are not all tantalised, and that the tantalum is filling a great want.

A. J. Abraham,
Electrical Engineer, Lanark County Council.

Cambuslang, *December 31st*, 1906.

With reference to the letter in your issue of 28th ult., I may say that I have had a considerable amount of experience with the tantalum lamp, with uniformly good results. This has been on a 200-volt D.C. circuit, with 100-volt and 65-volt lamps run two and three in series respectively. The average life has been well over 1,000 hours, in some cases running to 2,000 and 2,500 hours without serious blackening of the bulbs. The type of lamp was the high efficiency (1·7 watts per C.P.).

As regards the use of the lamps on A.C. circuits, the results which have come to my knowledge have been very contradictory. In one installation of 150 lamps on an A.C. supply, only two lamps gave out in the course of six months, and in another case (at Cambridge) the lamps gave perfect satisfaction. Even on high-frequency circuits the lamps have in some instances given good results, although on the Bristol circuit (93 cycles) very bad results have been obtained, most of the lamps giving out in less than a week. It is possible that the wave form of the current may affect the life of the filament. It would be interesting to know whether the makers have had any oscillograph diagrams taken on A.C. circuits on which they have had good and bad results respectively with tantalum lamps.

As regards over-running, my experience is that the tantalum lamps stand this very well indeed *where the voltage is steady*. Thus, for instance, 110-volt lamps run two in series on 240 volts give a very brilliant light, and have quite a satisfactory life if the voltage is kept steady at 240 volts. If, however, the voltage continually fluctuates 3 or 4 per cent., I find that it is much better to employ lamps suitable for the highest voltage reached. Thus on a declared 240-volt supply, where, from tests made, I have frequently found the voltage to rise to 246 or 247 volts, good results have been obtained by using two 125-volt lamps in series.

Another point regarding series burning is the proper "pairing" of the lamps. I find the makers now specially mark those intended to burn in series, which greatly simplifies matters in this direction. Formerly I found it was very necessary to test the lamps for "pairing," particularly in the cases were three lamps were to be run in series, as otherwise there was great risk of one of the lamps taking more than its proper voltage, with a serious reduction in its life.

I do not think the tantalum lamps can be greatly overrated, as from what is stated above they will stand a *steady* voltage considerably higher than that for which they are marked. Your correspondent's statement about the lamps burning brightly on one-third of the normal voltage seems almost incredible, but may, perhaps, be due to the whiteness of the light given by the lamps. I find that 110-volt lamps if run two in series on 200 volts do not *seem* to have any appreciable diminution in light, although I fancy a photometric test would show otherwise.

I hope to see some further discussion on these lamps, as I think they are the best form of lamp at present on the market. Cannot the makers hold out any hope of a high-voltage tantalum lamp yet?

H.

Rail Corrugation.

I am quite in agreement with Mr. Bowker that re-rolling is the most practical method to secure the best use of partly-worn corrugated rails. I am inclined to think, however, that corrugations would again appear, although it is quite possible that their life would be longer during the second period, sufficiently long, perhaps, for the rails to become worn out before they need be scrapped.

My reasons for thinking so are that the hard ridges of the corrugations when depressed into the metals in the rolling must add to the inequality of the rails. It is also possible that inequalities which existed in the rails when new would not be worn out before rolling became necessary, and it is doubtful whether annealing would eliminate this faulty structure.

I think Messrs. Bowker and Yerbury will agree with me that this improvement to be derived from continued rolling at low temperatures, which we are at one in thinking a good course of treatment, can only be little more than skin deep, but till there is a general improvement in the manufacture of rails the recommendations introduced, as a whole, are apparently of sufficient material value for tramway managers to take some action in the matter, experimentally at least, as the cost would not be a great consideration.

If any one has already tried the re-rolling of rails, it would be interesting to know the results, as regards both wear and absolute cost.

W. Thom.

Southampton, *December 31st*, 1906.

I have read with considerable interest the article by W. R. Bowker, on "Rail Corrugation," page 1031 in your issue of December 28th, 1906.

The subject is very important, both mechanically and scientifically; volumes have been written on steel and its qualities by many eminent metallurgists and scientists, but the prime factor in the making of steel that will meet all the requirements called for in modern engineering, has not been given the importance it is entitled to. What I refer to is the mechanical treatment of steel, from the ingot to the finished rail or other sections.

I read a paper last July in London, before the members of the Iron and Steel Institute of London, and the members of the American Institute of Mining Engineers of New York, in joint session (I enclose a copy). The subject was improvements in rolling iron and steel, I did not treat the subject exhaustively, but in a way to bring out in discussion what the views of the individual members were on this difficult problem, which is, that at the present time no ordinary rolling mills can produce a rail or other flange bar of a uniform physical quality. In rails as now rolled the head is always softer than the flange or web; these conditions are exactly the reverse of what is required to give the best service in the track. Rails can be rolled to give at least twice the present wear if rolled in a proper way, but it is impossible with ordinary rolling mills to obtain the results required. Steel may be said to be chemically uniform in the ingot or rail, providing there are no segregate parts left on the ingot, but this chemical purity loses its value relatively unless the steel is properly heated and rolled.

The shape of a rail section has a great deal to do with its physical qualities. As now rolled, the head of the rail (necessarily so) carries metal in a greater mass than the flange or web, and necessarily gets less work in rolling. Also the work that tells in the strength and wearing quality of rails is in proportion to the smallest areas, viz., flange and web, and it is only when the rail is almost finished and the areas are comparatively thin that the fining of molecular structure takes place that gives the strength and wearing qualities to a rail. This condition is also infinitely improved, if at this stage of the operation the rail rolled is at a proper temperature, say, 750 to 800° C.

The girder and Trilby rails so generally used in tramways are about the most difficult sections to roll (from their peculiar shape), and to get the best results, but generally these difficulties are overcome by heating the billet or ingot too hot, not necessarily burning it, but properly called overheating. The result is that the steel rolls much softer, but develops a coarse molecular structure in the steel which is highly detrimental to a good uniform physical structure. In the finished rail, this condition cannot be overcome by subsequent colder rolling, before the finish of the operation from this initial heat.

In rolling rails the ingot is rolled down to a square billet, always less in dimension than the height of the rail, consequently the table or head of the rail gets no compression to speak of except lateral incidental compression. Now it is compression under proper temperature and area that gives the very qualities desired in a rail. This condition cannot be obtained in ordinary mills, from the fact that the rolls would not keep the proper shape to roll a uniform section if the steel was finished at the heat to get best results; that is to say, they could not roll large tonnage without changing the rolls very much oftener than is now necessary, and this would be very expensive.

All steel rails and other bar sections rolled by the usual methods are stronger and closer grained longitudinally than across the sections, and this condition it is impossible to change from the generic principles of construction of ordinary rolling mills; so it is impossible to get a homogeneous physical structure under these conditions. It is said that there cannot be an effect without a cause; now the cause of rail corrugation is the question at issue. This question I have attempted to answer briefly in the statements I have made above. I shall now give some consideration to the views and suggestions in Mr. Bowker's article regarding the cause of rail corrugations, and the remedy for it.

I regret that I am writing this letter without having read the articles referred to by Mr. Bowker in *Electricity*, as they might anticipate some of the ideas I am now giving as my own.

Messrs. Yerbury and Thom, also Mr. Bowker, consider that the remedy for rail corrugation should be a homogeneous structure brought about by prolonged rolling; this could not be effected by ordinary rolling mills from the fact, as I have stated before, that it is impossible to roll a rail with a uniform physical or homogeneous structure, but these conditions can be brought about by the use of what is known as the universal rolling of rails, the process which is now owned by the York Traverse Process Co.

I am willing to admit that the annealing of a rail would free the latter from internal strains, and would also give uniform molecular structure, but at the same time the rail would be too soft to give the best results in service, and if rolled after annealing by ordinary methods, this would destroy the homogeneous structure, as no bar can be rolled and retain homogeneity of molecular structure by these methods.

The prolonged rolling of steel at low temperatures is the cure for the evil referred to, rail corrugation, &c., but in order to roll a piece of steel to give any effect to the conditions required, the rolling must be done when the rail or section assumes a comparatively thin area, that is to say, when the rail is almost finished, and you cannot roll a piece of steel without, practically, reducing its sectional area at each operation. I will now propose two methods by which the results desired can be brought about and guaranteed:—

First, the ordinary mills can roll down the ingot to a size sufficiently greater in weight per lineal foot than the rail desired, so that there is sufficient work left on the section, to be done by the universal mill in giving the prolonged rolling required; this would be the cheapest way of getting at the results desired. The other plan is to roll the ingot down to the size above referred to for re-rolling, then allow the rails to get perfectly cold, and then re-heat to a low temperature, but sufficiently high to do the work, and above the critical limit known in steel, namely, about 720° C., and roll until finished at low temperature. This would not only give the wearing qualities desired, but would remove the effects of any conditions of overheating occurring in the first rolling, also at the same time removing any internal strains left from the defective system of rolling now in vogue.

My universal mill referred to is so constructed that in every part of the section the metal is delivered at the same surface speed. This ensures that there are no internal strains left in the bar, that are so disastrous to rails and other sections breaking under shock.

It has been stated recently by a leading railroad engineer, that a rail is no good, comparatively, until it is re-rolled. Experience has already shown that a rail re-rolled under proper conditions, can be made to last at least twice as long as the rail now made by the usual practice. This subject can only be touched on in a letter vaguely, but if sufficient interest is shown by the engineers and iron and steel experts in this subject, I shall be pleased to give an illustrated talk on the scientific principles of rolling, and will attempt to show what I have stated above to be an absolute fact. Also I will give a practical demonstration of rolling, both on my Universal mill and transverse mill, which are stated by those qualified to judge to be revolutionary as regards the results obtained.

The York Transverse Rolling Process Co.
James E. York, *Director.*

London, E.C.,
December 29th, 1906.

The Conduit Trust.

In reply to the correspondents in your current number on the above subject, I am pleased to see that "Anti-Trust" and "Another Contractor" took similar steps to ourselves, viz, transferred their orders to a non-trust firm.

Replying to the joint letter of Messrs. Nalder and Northcote, I should like to ask how it is that standardisation has, in this case, sent up the prices 20 per cent., whereas, as a general rule, the very fact of standardisation means the lowering of the cost of production.

It is to be noted that not one of the "Trust" firms has ventured an explanation, which fact speaks for itself. Contractors, please note.

Contractor.

December 22nd, 1906.

Cost of Suction Gas Power.

Your issue of December 28th contains a letter over the signature "Ipso Facto," to which letter we are asked to reply.

Before doing so, however, we wish to know who is responsible for that letter, and for the communicated article which caused this correspondence. In doing this, we are only asking for information corresponding to that which your contributor possesses from knowing our name, our business and our address. What we require is the same information on these points with regard to your contributor.

The Campbell Gas Engine Co., Ltd.
W. Marsden.

Halifax, *December 31st*, 1906.

Nernst Lamp Renewals.

In the more recent issues of your paper, we have noticed considerable correspondence dealing with the advantages and disadvantages of the various types of Nernst lamps; this correspondence, however, has emanated chiefly from borough engineers.

It would be interesting, in our opinion, to learn the views of contractors and factors, and we think the expressions of opinion from the trade would be of great interest, and perhaps also of more weight in expressing the views of the public generally.

Corporation engineers, as a rule, unless there is a Nernst lamp maintenance scheme, only deal with the question of street lighting and the installation of municipal buildings. The trade, however, that is, contractors and the like, have to bear the expressions of opinion of the direct consumers, such as shopkeepers, and private house installations. We ourselves as factors of Nernst lamps for some few years, could say a great deal about them, but before doing so we should like the views of other large contractors and factors.

Trader.

Mains Testing.

Please refer me to the Nos. of the Electrical Review in which were articles on Insulation and Fault Testing on Three-wire Circuits. I should be much obliged if you could also recommend to me some book on testing three-wire and other circuits.

W. S.

[Many such articles have appeared in our pages. Confining our references to the last two years, the following may be useful:—Vol. 56, 1905, p. 340 (this article gave rise to a very lengthy discussion in our "Correspondence" columns); Vol. 57, 1905, pp. 408, 456; Vol 58, 1906, pp. 114, 493.

We cannot do better than recommend Mr. F. C. Raphael's book on "The Localisation of Faults in Electric Light Mains," and his "Wireman's, Linesman's and Mains Superintendent's Pocket Book."—Eds. E.R.]

ELECTRICITY SUPPLY TO THE WITWATERSRAND.

The race between the rival schemes which have been projected for supplying the Rand mines with electricity for power purposes has been won by the Victoria Falls Co. The Preference Share issue of £625,000 has been subscribed, and the allotment has duly been made. The inference that the other schemes for supplying the Rand with electrical energy have been beaten on their merits, however, would be far from the truth. The reverse is the case, for while there is but one winner, there is no loser. All the competitors have been swallowed up to form the one entity. This is well enough no doubt from the competitors' point of view, and more than well enough from the point of view of our friends the Allgemeine.

Our first care is naturally for the British manufacturer and for the British investor. How are they likely to be benefited by the deal?

As far as the contract for the pioneer plant is concerned, that is, of course, irretrievably lost to this country; but if the pioneer work of the company proves that the business of electric power supply to the Rand is a sound one, we imagine that our British manufacturers will take care that their claims are not overlooked in the direction of the supply of plant and mains extensions.

If indeed, as appears probable, the first works are laid down at Vereeniging, situated 35 miles from Johannesburg, transmission lines not at first contemplated will become part of the scheme, and their erection may fall to the lot of a British firm at a very early date.

In any case an important company has been successfully launched, whose sole object is the dealing with electricity supply, and even if our German rivals have secured the first contracts, they will, we think, find it very difficult to secure all that may follow.

We will now consider how the British investor stands. He is possessed of the £625,000 Preference Shares, and in respect of these is due a cumulative dividend of 6 per cent. per annum. The question as to whether he is likely to get it turns upon whether the company really intends, in its early years, to rely for its profit upon a steam-driven or upon a water-driven generating station.

The general body of engineering opinion is, of course, solidly against the extravagant scheme which has been put forward by the Victoria Falls Co. for the transmission of power from the Zambesi, with its singularly ingenuous hydraulic reserve device and the like. However, while the prospectus of the company vaunts this part of the scheme to the full, it must not be overlooked that all this is left to the future, and, instead of being invested in such an epoch-making departure, the money at present subscribed is, apparently, to be spent in a much more humdrum and common-sense direction.

From our reading of the prospectus, we gather that the present issue of capital is for the purpose mainly of erecting a steam-driven power station in the neighbourhood of Johannesburg, and the pioneer undertaking so created will have in reality no connection with the Falls scheme except in name. It is true that £1,000,000 in Ordinary Shares go in purchase of the water rights at the Falls, but it will probably be some years before there is a balance of profit available as dividend on these shares, since the preference shares have a prior claim to the extent of a cumulative 6 per cent., and by that time the development of Rhodesian industries may have turned the possession of the rights into a valuable property.

If the market for cheap power on the Rand is as extensive as it has been represented to be, there can be little doubt that a bulk supply undertaking on a sound scale would prove a remunerative undertaking.

Engineers experienced in this class of work will readily admit, however, that there is none too wide a margin between success and failure. Every effort must be made to attain the maximum efficiency at a minimum annual cost. The Victoria Falls Co., having bought out competing interests, has a fair field, and although it cannot get the best possible value for its money, since it is bound to buy its initial plant on an uncompetitive basis, nevertheless it is free to design its undertaking so that its working expenses will be a minimum.

For the sake of the British investor it is to be hoped that the engineers entrusted with the work will be allowed so to design the works, and that their hands will not be trammelled by any imaginary necessity for making provision for future combined working with a supply from the Falls.

For instance, it has been claimed that the best site for a power station from an economical point of view would be at Vereeniging, in the centre of coal-fields and alongside a copious supply of water. If this be so, and if the advan-

tages gained would compensate for the necessity of transmitting the energy over the distance of about 35 miles, it would be a misfortune if the engineers were precluded from adopting this site lest there should be an appearance of abandoning the water-power scheme.

The advocates of the Vereeniging site certainly appear to have a strong case. The advantage of free water, and of coal at 5s. a ton, held by this site, as against water at 3s. or 3s. 6d. a thousand gallons, and coal at 10s. 6d. a ton, the prices in vogue on the Rand, would seem far to outweigh the disadvantage of a comparatively short transmission line.

From the fact that Mr. Isaac Lewis, a director of the Vereeniging Estates Co., and one of the moving spirits in the now absorbed Vereeniging Power Scheme, is on the board of the Victoria Falls Co., it would appear that the claims of a Vereeniging site will at least be carefully considered.

We repeat, therefore, that so long as the undertaking is allowed to proceed upon sound common-sense lines, and so long as it is not further overloaded with cargo of the romantic order, there seems a fair prospect of success from the investor's point of view.

THE NEW PREVENTION-OF-CORRUPTION ACT: A CONSULTING ENGINEER'S VIEWS.

By BEN FRANK.

It must be delightsome to be an editor-in-chief, and from the comfortable recesses of an elegantly upholstered armchair (posed at this season of the year before a glowing coal fire), to order one's minions here, there and everywhere. Now, down a coal mine to report on the electric pumping equipment; then, in midwinter, to some mountainous district to report on a water-power station; and again, in the height of summer to some pestilential refuse destructor works to write up all the unwholesome details of the furnace house.

In instructing me to interview a consulting engineer on the probable effect of the new Corruption Act, with particular reference to the consulting profession, I have no doubt he smiled in his sleeve, and would have rather enjoyed seeing me return with my coat torn from my back and with my arm in a sling. But he reckoned without his host; one of my wife's relations happens to be a consulting engineer who holds strong views on the question of bribery and corruption.

As luck would have it, I met him, quite fortuitously, on the Saturday afternoon before Christmas. Before going home, I dropped into the "Valhalla" Café for a cup of coffee and a sandwich, just to keep the cold out, and there, seated at a small round table in the corner near the fire, was my friend—well, call him Quincent—very deeply absorbed, apparently, in some engineering problem.

"Hullo, old five-per-cent, what are you doing here on a Saturday afternoon, when you ought to be at home helping the kiddies to put up the holly and mistletoe? Oh, accounts is it?" I said, seeing a number of figures in money columns. This gave me an excellent opportunity to broach the subject of my interview. "What are you up to—calculating the loss of income for 1907, in consequence of the new Act? Ha, ha, ha!"

He extended a languid hand. "I might retaliate," said he, "by saying, 'well, Mr. Penny-a-Liner, now what are you after? Copy, I suppose, as usual.' However, come and sit down and let me wish you the Compliments of the Season."

"As a matter of fact," I remarked, taking a seat beside him, "You have hit the nail. I am after copy. The editor has asked me to obtain the opinion of some eminent consulting engineer on the new Corruption Act, which comes into force in the New Year, and, of course, I thought of you at once."

"I must stand you a cup of coffee for that. It is a little extraordinary that you should have come in here just now. There must have been some telepathic communication between us, because, as you see, I was just making up a statement of profits and losses on my conscience account."

"I am afraid that is a little too deep for me. I always thought that a conscience, like water-power, was a free gift of Nature. By the way, they make very good coffee here, don't they."

"That was a very apposite simile of yours. You are quite right, conscience is a free gift of Nature in exactly the same way as water-power is. In both cases the cost of upkeep is pretty considerable, if you make use of them."

"Well, if I may be so rude as to glance at your figures, they do not appear to indicate that you have made very much use of yours this year, because the figures appear to be all on one side of the ledger."

"Well, of course, there can never be any figures on the other side. These figures—of course, I am showing you these in strict confidence—are the actual amounts I might have had if I had accepted the various illicit commissions offered. All you get on the other side of the ledger is self-respect; and the problem is, 'How much is your self-respect worth to you?' On one side, so many hundred pounds; on the other side, nothing—or apparently nothing. The point is what money value do you set on your own self-respect? Now, a person who has never been in the position of having commissions offered to him, cannot appreciate the problem at all. It is the easiest thing in the world to resist the temptation which never offers. Such a one would say that he would not sacrifice his self-respect for the world, and would probably throw a text of Scripture at you; such, for instance, as, 'What shall it profit a man if he gain the whole world and lose his own soul?'"

"There is, I know, quite a common impression that consulting engineers are a very bad lot generally. For my part, I do not share that opinion. There are, of course, good and bad in all trades and professions, but I do not know that the consulting profession is any worse or, perhaps, any better than any other section of the community. For one thing they have far more temptations than most other people, although they do not always advertise the fact in technical papers.

"I know what you mean," I interrupted. "An eminent Westminster firm of consulting engineers wrote us that they had thrown a tender in the waste-paper basket because the tenderers included a commission to them. Quite right, too."

"Quite right, indeed! Now look here; I honestly believe that I have far more respect for a man who pockets a big fat bribe, and says nothing, than for one who refuses a paltry commission in order that he may pharisaically proclaim his virtue from the house tops."

"But," continued Quincent, warming to his subject, "your Westminster plaster saints must look to their haloes. What do you think of the American professor who, because he had the common honesty to hand over to his clients a cheque which had been sent to him by the contractors, actually read a paper on the subject recently before a scientific society, describing in considerable detail the whole transaction, and patting himself on the back, and saying in effect, like little Jack Horner, 'See what a good boy am I!' And yet, mind you, if I were to insert my name and address only in your advertisement columns, such people as these would probably hold up pious hands in horror at such a breach of professional etiquette, and even influence the Council of the Institution of Electrical Engineers to circularise the country to the effect that any consulting engineer who advertises is a charlatan. Advertisement is not always paid for. Why, if I were to write to the papers every time I refused commissions or credited my clients with them, I should have to ask you to reserve me a regular space."

"I wish you would give me some details of actual cases of the kind, that have come within your own experience. I feel sure that publicity is the only thing which will put a stop to the evil.

"Well," said my friend, after a pause, "these things come in various ways and various forms. To give you every instance I have come across or heard about would fill your paper, but I will give you a few typical cases of how these things are done. A short time ago I called in tenders for a small plant; it was not an electrical plant, the only electrical portion of it was the motor, and that was the subject of a separate tender. It was necessary to go round and inspect various installations in order to judge of the merits of the

various types of apparatus. I think that, speaking from memory, I called for four tenders, and two tenderers out of the four took it for granted that I should expect a commission. I had never before had any dealings whatsoever with any of the firms. In one case the representative of his firm, after showing me over an installation and chatting about it generally, put the matter pretty bluntly in this way: 'Well, Mr. Quincent, we are both men of the world, I suppose. Now, how much am I to reserve you on this tender?'"

"Of course, you pitched him into the gutter," I ejaculated.

"Had I been writing fiction I should have done so; but, to stick to the bald facts, I simply told this—well, gentleman, that I was paid by my clients, and was not in the habit of accepting commission from both sides. He promptly informed me that he was very glad to hear it, but that he could name consultants within a stone's throw of my place, who would take it from *three* sides if they could get it.

"Another of the tenderers did not even ask the question; they simply sent their tender marked *net*, and enclosed a letter saying that there was a 5 per cent. commission reserved for me."

"That went in the waste paper basket, of course," I suggested.

"No, you are wrong! It so happened that this plant was what I considered to be the best, and was the one I preferred, other things being equal; so I simply wrote the firm, saying that I noticed the price was subject to 5 per cent. commission, which I had deducted from their quotation. This firm's price, I might say, was already the lowest, quite apart from this special 5 per cent.

"I want to make it quite clear to you that these commissions were not offered by any electrical firm, but by firms of mechanical engineers, and I have come to the conclusion, based on many experiences of a similar character, that the system has arisen, owing, largely, to the fact that a very considerable number of mechanical engineers start for themselves as agents for various firms, and take on consulting work in their spare time. Of course, they are entitled to their 5 per cent., or whatever it happens to be, agency commission on all orders they get; and the consulting work and agency work, it appears to me, get mixed up. They are so accustomed to get their agency commision that it probably never occurs to them, in taking a fee from their clients, that they receive an agency commission for the plant from the manufacturer as well. It is wrong, absolutely wrong; and I maintain that a man cannot at one and the same time act as agent both for the buyer and for the seller."

"Then do you mean to imply that electrical firms never offer illicit commissions?" I queried.

"No, I don't say that, because I know they do; but from my experience, I should say that the system has grown to its present proportions by reason of the example and competition of firms of American or German origin. However, we must keep to concrete examples, for if I were to tell you all I hear about bribery and corruption, I should simply scandalise you, journalist though you be. I have a case in mind now of a quotation for some electrical plant; one representative in particular, the agent of a foreign firm, was very keen on the order, and besides calling on me, telephoned several times as well. He had apparently gathered from one interview that his price was not the lowest; so, on getting back to his office, he rang me up, and said that he had forgotten to mention that if a commission to myself would help matters at all, that could be easily arranged. In this case his tender received no further consideration, and had it been the lowest he would not have got the order."

"You seem to make fish of one and flesh of another, it seems to me, in dealing with these matters," I said in reply.

"Yes, I do. I take into consideration the circumstances of the case, and the way in which the commission is offered. If it is obviously offered with corrupt motives I wipe the thing right off the slate. Of course, the thing always is corrupt, but there are many cases where a commission is reserved simply as a matter of custom, and not as a deliberate attempt at corruption."

"Are there any other ways in which these commissions are offered to consulting engineers?"

"Yes; there is a tendency, and this I have only experienced in connection with firms of foreign origin, to induce a consulting engineer to specify for their goods, on the understanding that some commission will come to him for so doing. I was rather amused recently at a representative who called at my office several times in connection with some electrical accessories. I informed him that I was quite well acquainted with the apparatus referred to, and he replied, 'Could you not specify for its use on your installations?' I told him that I very rarely, indeed, specified any manufacturer's name in a specification, and only did so when it was absolutely necessary. He then went a somewhat roundabout way to suggest that his firm would be inclined to give me a commission on any goods supplied to any installations where they had been specified by me. 'Perhaps we could come to some arrangement,' he said, 'in case of your specifying our material.' To see how far he would go I said, 'What do you mean; what kind of arrangement do you mean?' Being a man of some perspicuity, he could see it was no use putting the matter too bluntly, so he merely contented himself by saying, humming and hawing a good deal, 'Oh, I thought perhaps we might make the thing a little more interesting to you,' and upon that I showed him out, and have not seen him since."

"But surely all this shows a very rotten state of things, in both the mechanical and the electrical industry?" I suggested.

"Yes, you are quite right: it is a rotten state of things, and to anyone who tries to 'play the game' it is most disheartening and discouraging to see men prospering and apparently in flourishing circumstances when one knows that the amount of work they are doing is not sufficient to warrant it. Consulting engineers are, of course, not the only men to whom bribes are offered. I rarely go into a works that does not reek of corruption. Someone has generally to be squared by a contractor before an installation works satisfactorily. The existing system of municipal management, too, lends itself readily to dishonesty. It is not an uncommon thing to see some small tradesman in not very flourishing circumstances appear to get on by leaps and bounds so far as appearances go, after having become a member of some local town council, and yet those who are in a position to judge cannot see that his business has increased very much in volume. The recent L.G.B. inquiries show pretty clearly what has been at the back of this kind of thing."

"Well, in spite of all you say," I hazarded, "I think that with a few notable exceptions, if consulting engineers can get a commission on both sides without being found out they are generally credited with doing it."

"I am afraid that you are basing a general statement upon one or two particular cases, and it would be just as fair for me to say that all journalists were corrupt, because I know of one or two cases where articles have been paid for both by the journal and by the manufacturer whose apparatus forms the subject of a descriptive article. I could point to articles in your own paper which you have paid the author for, and for which the author has also been paid by manufacturers.* I myself have been offered money to write up things in technical papers."

"However, to come back to the original question, for I must be off.—I can only say that, from my own point of view, I should welcome it if I thought it was an Act which could really be put into operation. But there are two strong objections to it: one is that it is necessary to prove corrupt motive either in the giver or receiver of commissions, a most difficult thing to do; and, further, the Attorney-General's permission has to be obtained before a prosecution can take place. Still, I think that the Act will do good, and all honest consulting engineers—and notwithstanding any impression to the contrary, they are not a few—will welcome any Act which makes it more difficult for bribery and corruption to take place.

"I could tell you a lot more, but perhaps you have enough

* We should be greatly obliged if Mr. Quincent would favour us with further particulars, to enable us to guard against a repetition of this iniquity.—Eds. E.R.

now to go on with," and with this he went off, to buy Christmas presents for some little folks who would not accuse him of corrupt motives.

PARLIAMENTARY.

Barnsley, Wombwell and Wath Tramways Bill.—It is proposed by this Bill, which is now printed, to incorporate a company with a capital of £114,000 to construct tramways in the West Riding of Yorkshire. There are about 12 miles of tramway specified, and the first directors of the company are to be Mr. H. G. Nicholson, Sir Thomas Dewar and the Rt. Hon. Sir E. J. Monson, Bt.

London and North-Western Railway Bill.—One of the most interesting Bills to come before Parliament next Session will be that of the London and North-Western Railway Co. who are going to develop their suburban traffic by the construction of a new line of railway to be worked electrically. Power is taken to acquire land for the erection of a generating station at Willesden, and also power to raise £2,700,000 additional capital.

London and District Electric Power Bill.—From the printed Bill bearing the above title it is intended by Sir H. Seton Karr, Mr. W. Rigby, Mr. W. T. Pressland and others to incorporate a company with a capital of £4,500,000 to supply electricity in London and in parts of Essex, Kent and Surrey. The areas scheduled are practically the same as those contained in the London County Council and the Administrative County of London Bills.

London County Council Tramways.—The estimated expenditure on the proposals brought forward in the L.C.C. Tramway Bill is £563,190 for the construction and equipment of tramways, and £118,520 for street improvements connected therewith.

Lower Thames Tunnel Railways.—Amongst the new schemes being brought forward this year, is that to incorporate a company with a capital of £975,000 to construct railways which will connect the London, Tilbury and Southend Railway with the South-Eastern Railways by means of railways passing through a tunnel under the Thames. It is proposed to work the railways electrically, and power is taken to obtain electric power from local authorities.

Royal Assent.—The following Bills received the Royal Assent in December:—

Falkirk and District Tramways (Extensions) Order Confirmation Act, 1906.

Edinburgh Suburban Electric Tramways Order Confirmation Act, 1906.

Ardrossan, Saltcoats and District Tramways Order Confirmation Act, 1906.

Dumbartonshire Tramways Order Confirmation Act, 1906.

Dunfermline and District Tramways Order Confirmation Act, 1906.

BUSINESS NOTES.

The Silvertown Co.'s Activity.—During the past year the India-Rubber, Gutta-Percha & Telegraph Works Co., Ltd., Silvertown, London, E., has executed an important contract for the Dumfries Corporation. Under agreement made with the Corporation, the company took over the provisional order obtained for the supply of electricity for lighting and power purposes, and contracted for the erection of the generating station, and the complete equipment of same. There are two boilers of the Lancashire type supplied by Penman and Co., Glasgow, each capable of evaporating 6,000 lb. of water per hour, working at a pressure of 160 lb. per sq. in. They are fed by a Weir steam pump, and a Pearn electric pump driven by a "Silvertown" variable speed motor having a speed range of about 4 to 1. The economiser is of Messrs. Green's standard type. The engine room contains two 100-KW. "Silvertown" dynamos direct-coupled to Messrs. Belliss & Morcom's latest type of steam engines. The condensing plant consists of a "Ledward" evaporative condenser capable of dealing with 6,000 lb. of steam per hour, an "Edwards" air-pump driven by a "Silvertown" variable speed motor, with a speed range of 4 to 1, and a circulating pump also direct-coupled to a "Silvertown" motor. The battery consists of 128 Chloride cells, each having a capacity of 1,000 ampere-hours when discharging in 9 hours, and an emergency capacity of 500 ampere-hours when discharging at a rate of 500 amperes. The switchboard consists of separate panels for each generator, and separate panels for the feeders, arranged so that the compound wound generators will run in parallel. The board is provided with all the usual circuit breakers, switches, and instruments. The engine room is completed by a travelling crane capable of lifting 7 tons, and supplied by Messrs. Herbert Morris & Bastert, of Loughborough. Ample provision has been made for extensions to the generating plant by building the power house large enough to accommodate two additional sets of 200 KW. each. The station was opened by the Provost of Dumfries on December 21st last. The India-Rubber Co. designed and supervised the erection of the building, through its resident engineer, Mr. Best.

In addition to having executed various contracts for extensions to central stations, the Silvertown Co. during the past year equipped a new power station for its works at Persan-Beaumont, France. The building is of steel frame construction, the walls being filled in with local stone. The boiler house contains three Lancashire boilers, 30 ft. × 8 ft., with an economiser, and steam and electric feed pumps. The generating plant consists of three "Silvertown"-Belliss 200-KW. steam sets, working in conjunction with Körting condensers, one to each engine, each condenser having its own circulating pump driven by a "Silvertown" motor. The station is built of such size as to provide for extensions to double the present capacity. The switchboard is arranged with generator panels to allow running in parallel with the compound-wound generators; and a number of panels from which are run the cables distributing the current over the factory. There is, in addition, a small battery with separate battery switchboard and motor-booster, which will be available for supplying current for lighting the residence of the works manager, and the offices when the main plant is not running. An overhead travelling crane of 10 tons lifting capacity is provided in the engine-room. The new station will supply current for lighting the works, but the greater part of its output will be utilised for driving the machinery in the shops, as the existing steam drive is gradually being converted to electric drive.

The company also executed a very important contract for submarine cable laying, 1,300 nautical miles of cable being laid for the Commercial Pacific Cable Co., between Shanghai and Manila. The work was commenced during the month of January last, and completed at the end of July. The cable weighed nearly 5,000 tons, and was laid by the company's cable steamer *Silvertown*. The latter is remarkable for the great size of her cable tanks, as may be judged by the weight of the cable recently laid. The steamer is capable of carrying a cargo of more than 6,800 tons. Submarine cable-laying forms quite an important part of the company's business, another of its cable steamers, the *Buccaneer*, having been busily engaged during the past year in repair work for a number of cable companies.

Stirling Boilers in 1906.—During the year which has just closed exceptional activity has been experienced by THE STIRLING BOILER CO., LTD., of Motherwell. We understand that in number of boilers dispatched and orders booked it was the most satisfactory year the company has experienced, and the company is fully occupied at the present with the execution of many large and important contracts. Trade has been exceedingly brisk with the various iron and steel works throughout the kingdom, and the company has opened accounts with many important and well-known firms. Many repeat orders have been received for boiler plant from former customers in this line of business, and also from municipal and other large electric light and power stations, including the county borough of Grimsby, the Newcastle and District Electric Lighting Co., Ltd., a complete boiler house plant, consisting of boilers and accessories, for the Newcastle-upon-Tyne Electric Supply Co., Ltd., being a duplicate of the plant ordered last year by this Co., the Sheffield Corporation Tramways, the Copenhagen electric light station, and the Corporation of Glasgow. The company have also supplied, or are executing orders for, boiler plant for the Madras tramways, the Urban District Council of Colwyn Bay, the Walsall Borough Electricity Department, the Municipal Council of the City of Sydney (including boilers, superheaters, stokers, piping, &c.), the Delhi tramways, the Urban District Council of Epsom, the Hereford electricity works, and an independently fired superheater for the London Electric Supply Corporation. Repeat orders from important municipal undertakings and from such well-known firms as Messrs. William Beardmore and Co., Ltd., the Consett Iron Co., the Farnley Iron Co., &c., furnish a most valuable testimonial as to the satisfactory working of the Stirling boiler.

Electrical Apparatus under New Canadian Tariff.—A Canadian correspondent sends the following notes on this subject:—Telephone and telegraph instruments, electric and galvanic batteries, electric motors, dynamos, generators, sockets, insulators of all kinds; electric apparatus, n.o.p.; boilers, n.o.p.; and all machinery composed wholly or in part of iron or steel, n.o.p.; and integral parts of all machinery specified in this item:

New tariff.—British preference, 15 per cent; intermediate, 25 per cent.; general, 27½ per cent.

Old tariff.—British preference, 16⅔ per cent.; general, 25 per cent.

This is an increase in general, and reduction in preferential. The clause "all machinery, n.o.p.," practically covers all machinery except special machinery provided for in the free list or at lower rates. It will be observed that the ratio of preference has been substantially increased.

"Manufactures of iron and steel, n.o.p.," British preference, 20 per cent.; general, 30 per cent. The number of articles of iron and steel which were specified in the old tariff, are not specially named in the new tariff. This will fall under the general item. Iron and steel castings, in the rough, formerly 25 per cent. are now, however, 30 per cent.

Electro-Chemistry in Italy.—The Società Italiana di Elettrochima, of Rome, which was formed several years ago by, among others, the Baden Aniline Works, and by Swiss financiers, holds concessions for the utilisation of considerable water-powers in central Italy, including the power of the rivers Tirino and Pescara. The first station in the Pescara Valley is expected to be started in a few weeks from the present time, the plant comprising five generating sets of 2,800 H.P. A total of 6,000 H.P. has already been contracted for by the Aluminium Co., the Società Prodotti Azotati,

and the Società Abruzzere, which have also been constituted with the participation of German capital. It is also proposed to utilise the power of the second and third falls of the Pescara River, which will yield from 22,000 to 29,000 H.P. The work for the extension of the factory for the production of electrolytic products is progressing, and will be finished in 1907. As the demand for chlorine manufactures is limited, it is not intended to extend the branch as was originally contemplated, but to devote attention to other products. The Società Prodotti Azotati has completed its installation for the output of copper sulphate and mineral superphosphate, &c., and the factory for calcium cyanamide is already partly in operation. The Aluminium Co. expects to start its furnaces during this month, and all branches of manufacture will then be taken up. The share capital of the parent concern of the three companies—the Società Italiana di Elettrochima—now amounts to £540,000, in addition to £120,000 in obligations, and the net profits realised in 1905-6 reached £30,700, as compared with £31,600 in the preceding year. A dividend at the rate of 6⅝ per cent. has just been declared for 1905-6, being the same rate as was paid for the previous 12 months.

The International Glow Lamp Syndicate.—It is reported that the International Glow Lamp Syndicate, which was formed at Berlin in 1903 under the title of the Sales Bureau of the United Glow Lamp Works, has failed to accomplish the object it had in view. The combination was constituted by 16 of the principal makers in Germany (including the Allgemeine Co. and the Siemens & Halske Co.), and in Austria and other countries, for the purpose of guaranteeing the delivery of uniformly good lamps from a technical point of view, and regulating the market and price conditions of the lamps, the duration of the syndicate being fixed at 10 years. It now appears, according to information received by the Berlin *Tageblatt* from circles associated with the syndicate, that the latter has experienced a complete check in regard to the attempted control of the market and of prices. At first the prices of lamps were increased by from 50 to 100 per cent., but it was soon found necessary to grant rebates which largely rendered the higher prices illusory, as no fewer than 11 new glow lamp factories were brought into existence in competition with the syndicate. The assistance received from the largest outside maker—the Bergmann Electricity Works Co., of Berlin—did not help the syndicate very much, although the company, without joining the combination, entered into an agreement to work in conjunction with it. At present the situation is such that owing to the rebates, the increase in wages, and the higher cost of raw materials and the competition of outside firms, the actual prices have again been depressed to about the level which obtained prior to the formation of the syndicate.

The Price of Copper.—The *Morning Post* says that consumers of copper in Birmingham and the Midlands are disturbed by the continuous advance in copper, the English standard having risen £12 per ton in two months, and £40 from the lowest price of the year. Lake copper is still taking the lead, and the American syndicates practically control the situation. Most English consumers are buying from hand to mouth, and are consequently paying maximum prices. In view of the immense demand for electrical and motor industries higher prices are anticipated.

Annual Dinner.—The employés of MESSRS. A. REYROLLE & Co., LTD., held their annual dinner at the Station Hotel, Hebburn, on Saturday, December 22nd. There was present a company of more than 90, and Mr. A. C. Reyrolle presided. Mr. A. E. Nicod proposed the toast of "The Firm." Mr. H. W. Clothier replied, in the absence of the secretary, Mr. Norbert Merz, who was indisposed. He said that the year which was just closing had been one of very substantial progress for the company. The orders showed an increase of 150 per cent. on last year's, and the extensions and additional plant which had been installed during the year had more than doubled the productive capacity of the company. Mr. A. C. Reyrolle thanked the employés for their hearty co-operation in the past and rejoiced at the happy and pleasant relations which had always existed between the management and the employés. After dinner, the remainder of the evening was spent in harmony.

Trade News from Abroad.—In regard to our comments under this heading in our last issue, we are now able to give, from an official handbook just published, the following further information concerning the new arrangement which has been made by the Government Departments. The official notice reads:—

"The Commercial Intelligence Branch of the Board of Trade has been in the habit of forwarding to Chambers of Commerce for the confidential use of their members, but not for publication, information to which it has appeared desirable, in the interests of British trade, to draw attention confidentially.

"The plan has met with general approval, and it is intended to continue and extend it. In order to attain more fully the purpose of the Board—namely, to reach all British manufacturers or traders interested, it has been decided, on the recommendation of the Commercial Intelligence Committee, to supplement the existing system, by opening on January 1st, 1907, a register at the Commercial Intelligence Branch, 73, Basinghall Street, E.C., of British firms who may desire to receive confidential information relative to their respective trades.

"British firms desiring to have their names entered on this list should apply to the Commercial Intelligence Branch on the form which has been prepared for the purpose, copies of which may be obtained on application at the offices of the branch.

"The admission to the register, as well as the retention upon it, of any firm will be at the discretion of the Board of Trade. It is not proposed to make any charge for information supplied, but every firm admitted to the register will be required to become a subscriber to the *Board of Trade Journal* (and register as such with Messrs. Wyman & Sons, Ltd., Fetter Lane, London, E.C.), in order to ensure that those who wish to receive confidential information should first be in possession of all the official information relating to their particular trade which is published in that journal.

"The present scheme is provisional and experimental, and its continuance and future development will depend on the results of experience."

The above notice appeared in a handbook to the Commercial Intelligence Branch of the Board of Trade, which is on sale at the Government printers (2d.). A copy of this publication ought to be in the hands of all firms interested in trade development abroad. It contains a great deal of very useful information, including a list of commercial correspondents in the British Colonies.

Copper during 1906.—In their annual report on trade during the past year MESSRS. BOLLING & LOWE make the following observations on the subject of copper:—"The period of scarcity of copper, which, we stated in our report last year, appeared to be in view, has really been entered upon, and the result has been witnessed in a prolonged period of rising prices, which has lifted quotations to unprecedented levels. The utmost energies of the mine-owners have entirely failed to keep pace with the growth of demand during the past 12 months, and it seems to-day as if the world stood almost upon the verge of a famine. The old theory that, with copper at £65 per ton, production would be augmented to such an extent as to bring down the price to a level more nearly approximating that of production, has had to be discarded. Most mines must be working to-day at a profit of from 5d. to 8d. per lb. on their output, and, in spite of the inducement to do so, are unable very largely to increase their productive capacity. The chief source of consumption is still in connection with electrical requirements, and there is no reason whatever to anticipate any slackening in this respect. New copper deposits have made no impression upon the relative poverty of supplies, for consumers have taken, with avidity, everything offered them, and although it may seem hazardous, with prices at what appear to be an extravagent level, to anticipate further appreciation, it is difficult, taking a dispassionate view, to believe that the apex of the movement has yet been attained."

Co-operation in Austria.—It is announced that negotiations are proceeding between various companies with a view to the adoption of common action in respect of large transactions. The firms concerned are the International Electricity Co., the telephone and telegraph works of Czeija, Nissl & Co, the Vienna branch of the telephone factory of the J. Berliner Co., of Hanover, and the Vienna branch of the Siemens & Halske Co. It appears the negotiations largely relate to patents for automatic telephone stations, and that they aim at an interchange of experience and at manufacturing and selling on common account, without in any way interfering with the financial independence of the firms in question.

Price Increase in Germany.—The further advance in the prices of raw materials, and particularly in the case of copper, has induced the leading German electrical engineering firms to make a fresh increase in the charges for generators, motors and transformers. At the beginning of 1906 the nine firms concerned brought into operation an augmentation of 10 per cent., and at the end of February the rate was raised to 15 per cent. The new increase, which is also on a 5 per cent. basis, came into operation on January 2nd, thus making a total rise of 20 per cent. in a period of 12 months. This advance brings the heavy electrical engineering branch on an equality with the light electrical branches in the matter of higher prices, seeing that the quotations for telephone and telegraph apparatus were recently advanced by 10 per cent., making a gain of 20 per cent. in the past year.

Bankruptcy Proceedings. — HERMANN DIAMANT (lately trading as Chiesa Diamant & Co., dealers in electrical goods, 153, Shaftesbury Avenue, W.C.).—At the London Bankruptcy Court last week the above-named debtor appeared for his public examination before Mr. Registrar Hope, upon a statement of affairs showing liabilities to unsecured creditors amounting to £784, and assets nil. In reply to Mr. Bowyer, Assistant Official Receiver, the debtor stated that he was a Polish Jew, and came to this country from Cairo in 1900. He formerly practised as a physician in Cairo for some nine years. His object in coming to this country was to assist the petitioning creditors in the formation of a company. In June, 1904, he took premises at 153, Shaftesbury Avenue, W.C., where he, in conjunction with the inventor, subsequently carried out experiments with a view to perfecting an electrical lamp, and they also carried on a general electrical business, under the style of Chiesa Diamant & Co., dealing in all kinds of electrical sundries. In October, 1905, they agreed to sell the patent rights in the invention, other than the French, Austrian and Belgian, for which provisional specifications had been taken out, to a company to be formed to acquire them for £12,000 in cash or shares. They subsequently agreed that half the purchase consideration should go to another person who had provided the necessary funds for the experiments. The company, however, never went to allotment. It was called the Diamant Arc Lamp Co. Witness attributed his failure to costs in the action brought against him by the petitioning creditors. He won the action in the lower court, and obtained £750 damages, but upon appeal the judgment

was reversed. He did not become aware of his failure until the case was decided against him. The examination was concluded.

It is stated in the *London Gazette* that the first meeting of creditors and public examination of Mr. Ernest Crompton Holt, carrying on business as an electrical engineer under the style of Holt & Co., at Queen's Arcade, Rhyl, will be held on January 9th at Chester and on January 10th at Bangor, respectively.

Dissolutions and Liquidations.—LONDON ELECTRICAL SYNDICATE, LTD.—A meeting is to be held at 154, Abbot Road, Poplar, E., on January 30th, to hear an account of the winding-up by the liquidator (Mr. Geo. Pearson).

A.B.P. ACCUMULATOR CO., LTD.—Creditors must send particulars of their debts, &c., to the liquidator (Mr. T. A. Pallister, Parkfield Works, Stockton-on-Tees), by February 1st.

The partnership hitherto existing between Messrs. John E. Bilton and Edward C. Harris, carrying on business as electrical and mechanical engineers at Albion Street, Heckmondwike, under the style of the GENERAL ENGINEERING CO., has been dissolved by mutual consent as from 31st ult.

Trade Announcements.—MESSRS. BRAY, MARKHAM AND REISS, LTD., have appointed Messrs. Potter, Thomas & Co., 1, St. Nicholas Buildings, Newcastle-on-Tyne, as their sole agents for the Counties of Northumberland, Durham, and the Cleveland District of Yorkshire, and inquiries and orders may be sent to them. Messrs. J. Parkinson & Co. have now ceased to represent the firm.

The UNBREAKABLE PULLEY AND MILL GEARING CO., LTD., of West Gorton, have appointed Mr. A. J. Crawford (Northern Mill and Mine Furnishing Co.), Carlisle, as sole agent for the sale of their specialities in Cumberland and Westmorland, and Furness, in Lancashire.

MESSRS. WALLACH BROS. have removed from 57, Gracechurch Street, E.C., to Royal London House, Finsbury Square, E.C.

The HUNSLET ENGINE CO., LTD., of Leeds, have appointed as their sole London representatives Messrs. J. E. Lawler & Muirhead, of 39, Lime Street, E.C.

MESSRS. ALEX. TURNBULL & CO., LTD., of St. Mungo Works, Bishopbriggs, Glasgow, have just taken over the business of the Harrison Engine Co., Ltd., Salford, Manchester, makers of the Harrison patent steam steering gear. The old works will now be closed, and the business transferred to Messrs. Turnbull's new works situated at Bishopbriggs, Glasgow, where the work will be carried on under the same management as at Manchester.

The HART ACCUMULATOR CO., LTD, Marshgate Lane, Stratford, London, announce that their telephone number has been changed to 1306 East, and that they now have an additional line, the number of which is 1307 East.

From January 3rd the business of MESSRS. WM. MCGEOCH & CO., LTD., will be conducted from their large new premises, the main entrance of which is at 28, West Campbell Street, Glasgow.

MESSRS. JOHNSON & PHILLIPS, LTD., have entered into an arrangement with Messrs. Welding & Co., of 64, Stanley Street, Liverpool, and 8, Prince's Chambers, John Dalton Street, Manchester, to represent them in Lancashire and Cheshire. They also give notice that the agreement with Messrs. Scattergood and Johnson, of 7, Cookridge Street, Leeds, to represent them in the Yorkshire and Nottinghamshire area has terminated, and all inquiries and orders should be sent direct to Victoria Works, Charlton.

MESSRS. SANDERS, REHDERS & CO. give notice that they have converted their business into a limited company, under the style of Sanders, Rehders & Co., Ltd., as from January 1st, 1907. Mr. Charles King, who has been for many years associated with the London markets, joins Mr. Sanders as managing director. The capital of the company has been fixed at £50,000, divided into 10,000 shares of £5, of which £20,000 are left for future issue; but all shares are controlled solely by Mr. Sanders and Mr. King, and the business will be under their immediate and personal management. Business will be carried on as heretofore at the same addresses. All debts of the firm will be paid by the company, and all debts, due to the firm, will be received by the company.

MESSRS. W. W. NORMAN & GILLITT have entered into partnership as Norman & Gillitt, at 91, Pilgrim Street, Newcastle-on-Tyne. Mr. Norman is retiring from the direct representation of the A.E.G. English Manufacturing Co., but will continue to supply Nernst lamps for the Northumberland and Durham district.

MESSRS. WOOD & THORNTON, of Ilkeston, have laid out works specially suitable for all kinds of continuous and alternating-current repairs, the renewing of commutators, &c. A speciality is to be made of colliery work.

Catalogues, Calendars, Lists, &c.—From MESSRS. WATTS, FINCHAM & CO., Billiter Buildings, E.C., we have received a large hanging calendar with monthly slips, which will keep the user in mind of the fact that they supply iron and steel and general engineering stores.

From MESSRS. GEIPEL & LANGE, of Vulcan Works, S.E., we have received one of their pocket diaries (Letts's) for the current year. A good deal of calendar, postal and tabulated electrical and general engineering information precedes the diary portion of the book.

JOSEPH DIXON CRUCIBLE CO., 26, Victoria Street, S.W.—Booklet relating to their special lubricating graphite (No. 635) and its uses.

EDISON & SWAN UNITED ELECTRIC LIGHT CO., LTD., London, E.C.—Two new leaflets: One (F 2,079), illustrating and pricing their adjustable piano or reading desk standards for electric lighting, and the other (F 2,076) showing examples of three-light and six-light electroliers.

MESSRS. JACKSON BROS., The Broadway, Plaistow, E., have sent us a tear-off monthly calendar, with memorandum slip at the side for every day in the month.

MESSRS. JOHNSON & PHILLIPS, LTD., have favoured us with a useful monthly tear-off calendar for the wall.

The ARMORDUCT MANUFACTURING CO., LTD., of 6, Farringdon Avenue, London, have provided us with a set of memo. refills for the file which they sent last year. We note that their motto for Sundays is "Forget Armorduct!" We have also received from them a price sheet of various classes of motor-car cables supplied by them.

A very useful diary has come to hand from MESSRS. MCCLURE & WHITFIELD, of Stockport. Its opening pages contain illustrated descriptive matter, with tabulated prices, voltages, speeds, &c., of "Mersey" type electric generators and motors. For the rest we need only say that it is one of Letts's very popular diaries, with the usual insurance coupon.

The SUN ELECTRICAL CO., LTD., of 118 and 120, Charing Cross Road, have forwarded an excellently illustrated 16-page catalogue, No. 150, Section H, of electrical radiators and cooking apparatus; references, dimensions, prices and other particulars are included. Also a list, No. 153, of electrical signs, containing illustrations, prices and descriptive matter.

MESSRS. H. A. JACKSON & CO., of Canton Hall, Salford, forward price lists of radiators, cables, glow lamps, &c., including the "H. A. J." incandescent glow lamp.

From the Loughborough Corporation Electricity Department we have received a copy of the local almanack and diary, in which the claims of the "best of the Council's undertakings," viz., the electricity department, are urged on the ratepayers.

MESSRS. W. H. WILLCOX & CO., LTD., of 23, Southwark Street, S.E., send us a "Date Remembrancer" (we thank them for that phrase), bordered with illustrations of their many and various engineers' stores.

The ELECTRICAL CONSTRUCTION CO., LTD., of Wolverhampton, send us two very acceptable and useful New Year souvenirs, in the shape of a neat paper-knife, and a 5-ft. steel tape graduated in inches and centimetres.

By means of a serviceable glass paper-weight, MESSRS. J. B. SAUNDERS & CO., of Westminster and Bute Docks, Cardiff, are announcing that this is the year of their jubilee, they now having been established 50 years.

Marylebone Borough Council v. R. N. Cunningham and Co.—This action was tried at the Marlborough Road Police Court on December 20th. It appeared that an electrician in the employ of the defendant company accidentally connected two lights belonging to one of their customers on the wrong side of the Council's meter. Mr. Cunningham conducted his own case, and the summons was dismissed.

Bergtheil & Young, Ltd., v. R. N. Cunningham and Co.—This was the appeal of R. N. Cunningham & Co., 171, Edgware Road, W., in the Divisional Court against a decision against them in the Mayor's Court in the earlier part of the year. Their Lordships were of opinion that a wrong decision had been given and referred the case back to the Mayor's Court, to be retried.

The British Westinghouse Electric and Manufacturing Co., Ltd.—A New Year's dinner was given by Mr. C. S. Colton, manager of the export department, to a gathering of the members of his London staff, at Romano's, on the 2nd inst. Entertaining speeches were contributed by the chairman (Mr. Colton) and Messrs. Thompson and Rogers. The musical programme was supplied by Messrs. Burland, Gibbon and Saklatvala.

New Works in Italy.—It is reported that the WESTINGHOUSE Co. are about to lay down extensive plant in Milan, at a cost of £250,000, with a view to obtaining the contracts for electrifying Italian railways.

Book Notices.—*Die Wirklichen Grundlagen der Elektrischen Erscheinungen.* By Johannes Zacharias. Berlin: Julius Bohne. 1906. Price M. 6—Readers of the ELECTRICAL REVIEW may be acquainted with the unusual nature of Herr Zacharias' theories, as they have occasionally been ventilated in our "Correspondence" columns. The present volume professes to give what the author, with some presumption, calls the "true" basis of electrical phenomena. Actually the book contains little more than unsupported contradictions of a number of generally accepted views on electricity and magnetism, together with complaints as to the cold reception given by the scientific world to the author's views. The insufficiency of the existing theories in explaining electro-magnetic effects may be readily admitted, but the suggested alterations, so far as they can be gathered from the present discursive statement, provide nothing definite in place of them. The author considers that facts and effects which have hitherto been indicated by such terms as magnetic poles, induced magnetism, magnetic lines, molecular magnets, the magnetic circuit, &c., can all be directly explained by an application of the ordinary laws of mechanics to etheric motions. The idea is not new, and just how the application is to be carried out is extremely vaguely indicated, and the experimental support offered for the views put forward is altogether inadequate for serious consideration.

Fowler's Architects' and Builders' Handbook. Manchester: Scientific Publishing Co. Price 2s. 6d. net.—This is a new handbook for the building and allied trades, compiled with the aid of a number of experts. It comprises 526 pages, packed with useful information regarding materials, methods, styles, by-laws, &c., and numerous mathematical, geometrical and other tables. There is an electrical section, which appears to be fairly correct, though the suggestion that carbon-filament lamps taking 2·5 watts per candle are available is somewhat misleading. Metallic filament lamps should

be included in the next edition. Fuses should not be put in ceiling roses or wall-sockets. Diagrams of simple switchboards are given; these might be made much clearer, and the battery connections in fig. 3, p. 365, are extraordinary—if the regulating switch were put on No. 2 contact, the dynamo would be dead-shorted. Moreover, 54 cells are insufficient for a 110-volt installation. Some errors occur in the section on electric cooking and heating; $C^2R/4{\cdot}2$ does not give calories, nor is $C^2R \times {\cdot}0094$ equivalent to B.TH.U. On p. 373, we read "if 1,000 B.T. units cost 2½d. (a usual rate for power in the daytime)." This strikes us as distinctly cheap. On p. 374 the word "dynamotor" should be replaced by "motor-generator;" and there is no sense in observing that the + and − terminals of a motor are marked. To say of series motors that the "speed varies with load" is misleading; the speed falls as the load increases. It is erroneous to suggest (p. 380) that only continuous current can be used for lifts. Lightning conductors, we are told, are not now earthed to water pipes, on account of the corrosion of the pipe joints by electrolytic action.

While we recommend the book as a whole, we strongly advise the compiler to have the electrical section revised by a competent electrical engineer for the next edition.

The Science Year-Book (1907). Edited by Major B. F. S. Baden-Powell. London: King, Sell & Olding. Price 5s. net.—This very useful year-book as usual contains a vast amount of information on scientific subjects, including astronomical data for the year, a summary of the past year's progress, physical and chemical tables, and a directory of scientific periodicals, universities and colleges, societies, biographical notes, and a very generous provision for diary (one page per diem), cash accounts and memoranda. As an experiment, those who do not require the diary, can now obtain the rest of the work without it. There is a frontispiece portrait of Lord Rayleigh, and the front cover is provided with a square opening, showing a monthly calendar, with detachable leaves, arranged as a convenient engagement memorandum. The book is admirably got up, and forms a really nice desk companion.

ENGINEERING POCKET BOOKS FOR 1907.—Quite a collection of these useful little books is now annually issued. Amongst these we note the "*Mechanical World*" *Pocket Diary and Year Book* (Emmott and Co., Ltd., Manchester, price 6d. net) as the oldest, most familiar, and certainly not the least useful. This being its 20th year of issue, the matter has been entirely reset in new type, and we congratulate the publishers on its improved appearance; at the same time the work has been thoroughly revised. Entirely new sections on gas engines, oil engines, suction gas producers, locomotives, reverberatory furnaces, &c., and many new tables, have been inserted. Good wine needs no bush, and the *Mechanical World P.B.* is known by its merits.

The "Practical Engineer" Electrical Pocket Book and Diary (Technical Publishing Co., Ltd., Manchester, price 1s. net), though much junior to its elder brother from the same office, is practically as big, and has won a place in the front rank of such annuals. Besides the usual revision, articles on conduit systems, fault localising, power generation and distribution, accumulators, arc lamps, &c., have been added, and there are now 474 pages. On p. 235 we read Baumé for Beaumé, and on p. 293 we learn that the osmium lamp has not yet reached the commercial stage, while the carbide lamp is mentioned as if it existed. Tantalum and Nernst lamps are briefly described. Some ancient matter appears under "arc lamps," and "Angold" is printed "Augold." The circuit-breaker on p. 319 is not shown in the correct position. On p. 323 appears an abstract of an article on electric lighting feeders, though the section in which it appears is devoted to traction. In "Mining," we see no reference to winding plant. Doubtless other defects could be discovered, but while they indicate the continual necessity of expert technical revision, they do not prevent the book from being a very useful one on the whole.

Fowler's Electrical Engineer's Handbook (Scientific Publishing Co., Manchester, price 2s. 6d. net) is the largest of its kind, containing 723 pages, of which nearly 100 are new. Much new information on meters, arc lamps, testing, photometry, dynamo design, &c., and new regulations, have been added. A directory of electric light and power stations and electric tramways, giving brief particulars of each, is included as usual. Very full information on lamps and lighting is given, and appears to be correct, so far as we have been able to examine it. Indeed, the more we turn over the pages of this book, the more we are impressed with the remarkable quantity of information which it contains, and we can confidently recommend it to our readers.

The Practical Electrician's Pocket-Book and Diary (London: S. Rentell & Co., Ltd. Price 1s. net) is produced in a totally different style from its rivals, making an exceptionally neat little volume. It has been revised and enlarged, the additions including chapters on electric traction, electric clocks, condensers, lightning conductors, flame arc lamps, boiler fittings, accumulators, mains, &c. This book also contains a directory of electricity works, a diary, and sets of forms for requisitions, estimating, &c. As a neat little compendium of information on almost all branches of electrical industry, this volume has justly attained a very considerable degree of popularity.

"Annuaire pour l'An 1907." Paris: Gauthier-Villars. F. 1.50.

"Science Abstracts." Sections A and B. Vol. 9, No. 108, December 28, 1906. London: E. & F. N. Spon, Ltd. 1s. 6d. each part.

"The Electrical Engineer's Ballad Book." A collection of miscellaneous verses reprinted from the *Electrical Engineer* and other sources. London: Biggs & Sons. 1s.

LIGHTING and POWER NOTES.

Barnstaple.—The T.C. has resolved to purchase 200 sets of new plates at 20s. per set from the A.B.P. Co., subject to the engineer's approval. It was stated that the Council had complained to the A.B.P. Co. that they were failing to keep the batteries in proper condition in accordance with their undertaking. After writing two or three letters, the Council was told that the company had gone into liquidation. The liquidator had written that he had 200 sets of new plates in stock, which he would sell at £1 per set, instead of 40s, and the Council's engineer (Mr. Hadfield) would inspect these at Stockton-on-Tees.

Bideford.—The T.C. intends to oppose the application made by the Mutual Electricity Supply Co. for a prov. order for the district. The Council habitually intimates that when such an application is to be made, it intends itself to obtain an order.

Canada.—TORONTO.—The Hydro-Electric Power Commission has written to the T.C. stating that the estimates of the Commission showed that electric power could be delivered in Toronto by the overhead system at about 1 cent. per KW.-hour to large consumers, and at about 2½ cents per KW.-hour for smaller users. The letter states that the prices charged to consumers by the Toronto E.L. Co. is from 2⅔ to 8 cents per KW. Regarding arc lighting, the letter says that, on a basis of 1,400 lights, the city could be supplied at the rate of $47.50 for the very best lights, and it might be possible to eventually reduce this figure to $40 per lamp. The present price is $67.35 per lamp per year. The Toronto Board of Control has asked for figures regarding house lighting.

In the next session of the Provincial Parliament, the City Council is to apply for permissive legislation to expropriate the Toronto E.L. Co.'s plant, or failing that, to have an Act passed reducing the profits of the company to 10 per cent. of its capital stock, the balance of the returns over and above expenses to be applied to the reduction of the price of energy to the consumers. The municipality complains that the company is not observing its contract with the city. It was capitalised at $4,000,000, and making 15 per cent. on its money, yet the lighting it gave was most unsatisfactory.

GALT.—A three years' agreement has been signed by the T.C. and the Galt Lighting Co. for an all-night electric light service. The contract is terminable if, in the interval, Niagara power should be transmitted to Galt.

OTTAWA.—The accounts of the Civic E.L. Commission for the half-year ended November 30th last show a deficit of $2,659. Of the $50,000 which the Railway and Municipal Board allowed for extension purposes, $33,415 has already been used, so that $16,585 remains for adding to the present lines.

HAMILTON.—On December 15th a somewhat peculiar and unforeseen accident at Decew Falls, shut down the power station of the Cataract Power Co., and Hamilton was deprived of a supply of electrical energy for several hours. It seems that the water, after passing through the power house, runs through a very narrow ravine and empties into a creek. During the night needle ice formed in the confined limits of the ravine, and the flowing water could not pass. The water, thereupon, backed up towards the power house, which is 10 ft. above the bed of the tail-race. The water soon rose above 10 ft., and flowing into the power house flooded the generators. The ice was removed by the aid of dynamite.

Cannock.—The U.D.C. has now received the sanction of the Board of Trade to the deed transferring the powers held under its E.L. prov. order to the Shropshire, Staffordshire and Worcestershire Electric Power Co. The deed provides that the company shall pay £500 to the Council for the transfer of the order, that the electric lighting shall be installed in a central area at Cannock within one year, at Hednesford within 20 months, and at Bridgtown within two years. On payment of the £500, the deeds will be exchanged, and a resolution will be passed by the Council giving the company permission to come into the district.

Coventry.—The City Council on Tuesday sanctioned the purchase of a new water-tube boiler with chain grate stoker, for the electric light works, at an estimated cost of £1,720, and instructed the city electrical engineer to prepare plans and obtain tenders for a fireproof extension of the boiler house to accommodate the new boiler.

Croydon.—The T.C. has decided to allow consumers of energy for lighting, the following rebates:—Consumers of £100 to £250 per annum, 5 per cent.; £250 to £500, 7½ per cent.; £500 to £750, 10 per cent.; £750 to £1,000, 15 per cent.; beyond, 20 per cent.

Dublin.—The Dublin Port and Docks Board have just successfully carried out an important improvement in their property, by equipping No. 2 slipway with electric power. This slipway was originally constructed in 1832, at a cost of some £15,000, and was at first worked by hand power. In 1860 steam superseded hand-power, and now electric power has superseded steam, and with the best of results. The carriage, which was made at the Board's works, and weighs 100 tons, is capable of accommodating ships up to 1,000 tons displacement, and the hauling apparatus consists of one of Messrs. Day, Summers & Co.'s non-fleeting winches, driven by a 100-B.H.P. motor, supplied by Messrs. Siemens Bros. As showing the advantage of electric power over steam,

we understand that a ship can now be hauled up in half an hour, as compared with from five to six hours under the old *régime*.

Dumfries.—The electricity works which have just been completed, were inaugurated on the 21st ult. The work has been carried out by the India-Rubber, Gutter-Percha, and Telegraph Works Co., who purchased the prov. order from the T.C. Particulars of the equipment, &c., are given elsewhere in this issue. The inaugural ceremony was performed by the Provost, amid a gathering of local people. The company afterwards visited the works and were entertained to tea. In the evening the India-Rubber Co. entertained a number of gentlemen to dinner, Mr. W. E. Gray presiding. The Provost, both at the ceremony and the dinner, expressed disappointment that the ratepayers should have decided to let a company carry out the scheme rather than the corporation. After reading his remarks, we wonder why he condescended to perform the ceremony. The company also gave a supper the same evening to about 40 workmen who have been engaged on the works.

Dundee.—The Electricity Committee of the T.C. has resolved to call in the services of an electrical expert to consult with and report upon the proposals made by the city electrical engineer as to the most desirable policy to be pursued, viz., whether a new station should be put down, or whether the Committee should extend the present one on the lines suggested by the engineer. It is agreed that whatever recommendations may be made, the works shall be carried out under the specifications and direction of the city electrical engineer.

Eccles.—The T.C. has fixed the following scale of charges for energy for power: For the first 100 units per quarter, 2½d. per unit; for the second 100, 2d.; for the third 100, 1½d.; beyond, 1d.

Glasgow.—The North British Railway Co. is installing a large number of motors at its new College Goods Station, Glasgow. The capstans, cranes and hoists in this building are all worked by electric power, and the lighting for the most part is also electrical. In the Caledonian Railway Co.'s St. Rollox shops at Glasgow, the electric power installation is now approaching 600 H.P., energy being obtained from the Corporation mains.

Greenock.—The Electricity Committee of the T.C. has placed the building tenders for a combined refuse destructor and electric power station.

Greetland.—In consequence of the opposition of the U.D.C., the Electrical Distribution of Yorkshire, Ltd., has withdrawn its application for an E.L. prov. order for the district.

India.—Bombay.—A recent number of the *Madras Mail* stated that the Bombay Government has issued a license empowering the Tata Syndicate to develop power in the Ghauts for industrial use in Bombay. Bombay could well do with 100,000 H.P. for power purposes, but the extent of the power is limited so that the Bombay Hydro-Electric Co. will only be able to supply about 40,000 H.P. There still, however, remains the consideration of the conditions of construction of the plant and distribution in the city. The scheme has been, we understand, fully considered by the Government, and the only objections that have been laid before it have come from the Bombay Electric Supply and Tramways Co., and the Bombay municipality, but inasmuch as the mill demand in Bombay amounts to approximately 90,000 H.P., and the Bombay Hydro-Electric Co. can supply but 40,000, there seems plenty of scope for the present company to extend its supply, even with the threatened competition of the new water-power scheme.

Kidderminster.—The E.L. Committee has found it necessary, owing to developments which have recently taken place, to considerably increase the plant, and it contemplates the expenditure of £10,000 in this direction. Several of the mills in the "carpet borough" have now adopted electricity for driving purposes.

Lancashire.—A trade correspondent learns that close upon a score more cotton mills—spinning and weaving—are to be electrically equipped in the Manchester, Bolton, Eccles and Leigh districts. Electricity is also to be tried at several more Lancashire bleach-works and collieries; in fact, electrical experts are confident that big developments will be witnessed this year.

Leyton.—The U.D.C. has resolved that the optional flat rate for energy be reduced as from January 1st from 4½d. to 4d. per unit, and that a new 8 or 16-C.P. lamp be supplied to each consumer of 25 units through slot meters. A large consumer in Leytonstone is to be supplied at 3½d. per unit, upon his guaranteeing a minimum payment of £300 per annum for energy. In regard to the new generating plant, a letter has been received from Messrs. Mather & Platt, intimating that they propose to supply two new armatures for the defective dynamos. This was agreed to, subject to the alteration being carried out in a maximum period of one day. As an experiment, three of the existing arc lamps on the main roads are to be converted into flame arc lamps, at an estimated cost of £50.

Mitchellstown (Ireland).—The R.D.C. has applied for a loan of £2,846 for the purpose of carrying out an electric lighting scheme.

Newcastle-on-Tyne.—The estimates for street lighting in the city for the year ending March 31st, 1908, just issued, provides for 837 electric arc lamps, at a cost of £5,067, as against £4,584 for 650 lamps in the current year, an increase of 187 lamps and £383 in cost.

New Zealand.—Mr. W. S. T. Goodman, who carried out the Waipori Falls power scheme and the electrification of Dunedin (N.Z.) tramways for Messrs. Noyes Bros., and who was recently appointed city electrical engineer at Dunedin (N.Z), proposes to introduce flame arc lamps into the city lighting.

Oakamoor.—Electric lighting has been introduced into the village. The residents have voluntarily provided the plant, fittings, &c., energy being supplied free by Messrs. Thos. Bolton & Sons, Ltd., from their works.

Penrith.—The U.D.C. has memoralised the B. of T. for an amendment order, enabling the E.L. order to be transferred to the Penrith Electric Supply Co. The company will pay the Council £300 and the costs of the agreement and the present application, and the Council is to have the opportunity of purchasing the undertaking at any time after ten years from the date of supply, at not less than the capital cost, plus 10 per cent.

South Africa (Vryheid).—The Local Board recently notified that it was prepared to grant a concession on or before 24th ult. for electric lighting.

Johannesburg.—At a meeting of the T.C. on November 28th the Traction and Lighting Committee recommended a new tariff to come into force as from January 1st, 1907, such recommendation being approved of by the Council:—

For lighting	.. 6d. per unit up to 7,500 units per month.	
,,	.. 5½d. ,,	from 7,500 to 10,000 units per month.
,,	.. 5d. ,,	over 10,000 units per month.
For power	.. 4d. ,,	at any time.
,,	.. 3d. ,,	except between 5 p.m. and midnight.

Meters will not be charged for, except in cases where there are small power circuits, which are taken off the present lighting main, when a charge of 2s. 6d. per month will be made. Minimum charges are on a sliding scale, from 7s. 6d. per month for installations not exceeding 25 8-C.P. lamps, and in proportionate rates up to a maximum of £25 per month for installations with over 2,000 8-C.P. lamps.

Brakpan (Transvaal).—Messrs. A. Goerz & Co. are about to greatly enlarge the power station of the Rand Central Electric Co. at Brakpan. The concession held by this company has been lately extended to 1936, and justifies them in increasing their plant. The tariff proposed is a flat rate of 1·05d. per unit, plus 1½d. for each hour run.

Pietermaritzburg (Natal).—The Town Council at a meeting on December 4th decided to reduce the rate for the supply of energy for domestic and power purposes, to 3d. per unit, plus 1s. per month for meter rent, with a discount of 5 per cent. for prompt cash.

Durban.—The borough electrical engineer has hit upon a novel way of educating the public on matters electrical, by using the backs of the E.L. accounts as an "Electrical Bulletin," in which from time to time domestic applications of electricity, advice on size, types and locations of lamps, the electrical department's doings, how to read the meter, how to test the meter, electric cooking and heating, &c., and other matters of interest to electric light consumers are given. Such an example might well be copied by our authorities, who are seeing the necessity of bringing themselves more to the fore and assisting their consumers with all useful information.

Sunderland.—Owing to the increasing demand for electricity at Sunderland, the borough electrical engineer has advised further extensions at Hylton Road power station. It is considered necessary to erect a new chimney, and install boilers and engines in time for next winter at an estimated cost of £44,000. The revenue for next year—1907-8—is estimated at £61,140, with an output of 9,920,000 units. The expenditure is estimated at £33,230, plus interest and sinking fund, making a total of £57,730, leaving a net credit balance of £3,410. There is an estimated increased demand of 1,650 KW., and it is recommended that a new steam turbo-alternator of 2,000 KW. should be installed. The question will be considered by the Committee shortly.

Wimbledon.—A Local Government Board inquiry has been held with regard to an application by the Town Council for a loan of £21,650 for E.L. purposes, the expenditure to be spread over the ensuing three years. It is proposed to lay out £13,500 on mains; £2,520 on meters; and £2,500 on transformers and substations. In his evidence, Mr. H. Tomlinson Lee, borough electrical engineer, stated that the service to customers was free and the cost varied from £7 to £7 10s., there being an average of 40 ft. of cable. The amount mentioned included the meter and all other charges. A discussion arose with regard to how the work would be executed. Mr. Lee stated that he would engage men who had been employed on and off for the last five years, and charge wages to capital account. The inspector, Mr. H. R. Hooper, said he did not approve of this method, and suggested that permanent maintenance work should be done by the permanent staff. From his own personal experience he could say there was no station properly run where men were unemployed for certain periods. The town clerk said the Council had a long correspondence with the L.G.B. on the matter, and that body had declined to give a definition of a permanent workman. The trouble was that the Council being obliged by law to have a considerable proportion of its work done by contract were unable to keep up an efficient staff. Mr. J. J. Caswell objected to the proposed expenditure in the parish of Merton upon the ground that a large proportion of the cost would fall upon the consumers of Wimbledon. He suggested that Wimbledon should supply energy in bulk to Merton, and that the local authority there should bear the cost of distribution.

(*Continued on page* 27.)

THE GREAT NORTHERN, PICCADILLY AND BROMPTON RAILWAY.

The opening on December 15th last, of the above railway, adds another important section to the scheme of electric railways being carried out by the Underground Electric Railways Co. of London.

The new railway, which has a route length of some 9 miles, connects the West and North of London, passing *en route* through the principal theatre, restaurant and shopping centres, linking up the District Railway and London United Tramway system at Hammersmith with the Baker Street and Waterloo tube at Piccadilly Circus, the Charing Cross and Hampstead line, now nearing completion, at Leicester Square, the Central London Railway at Holborn —where also the Strand branch of the new railway is accessible—the Great Northern and Midland termini and the Metropolitan Railway at King's Cross, also in the near future the City and South London Railway extension to Euston.

From this point the new tube follows the route of the Great Northern Railway to Finsbury Park by arrangement with that company, and in addition to the railway facilities at the latter station, gives access to the North Metropolitan Tramways. The new company has an authorised capital of some £7,000,000, and is leased to the Underground Co. in perpetuity.

In all 21 stations have been provided on the route, at distances averaging about one-third of a mile apart. At Hammersmith a terminal station has been constructed beside the present

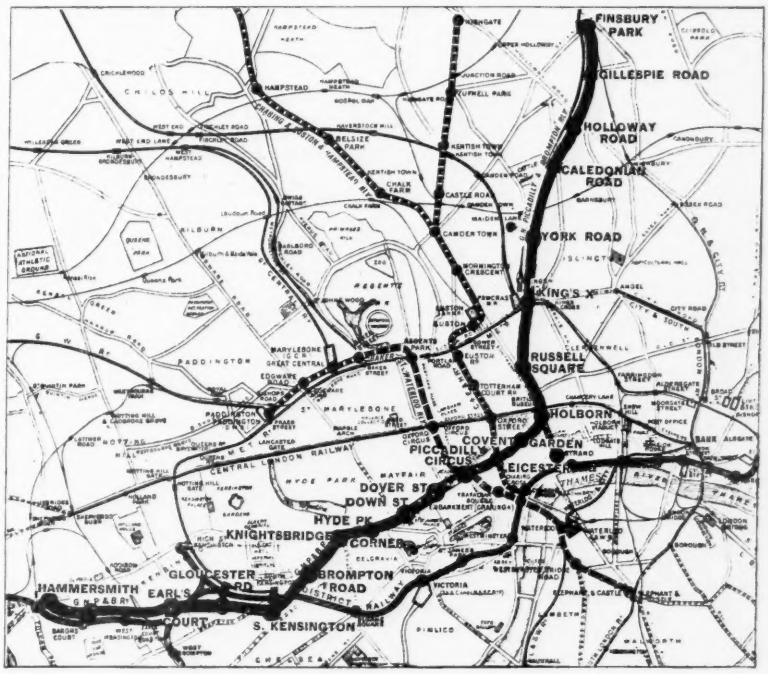


Fig. 1.—Diagram showing Route of the G.N., Piccadilly and Brompton, and Connecting Railways.

District station, and from this point the route lies alongside the latter railway, on the surface, for ¾ mile, when it falls by an easy gradient to the entrance of the double iron segmental tubes forming the underground section to Finsbury Park.

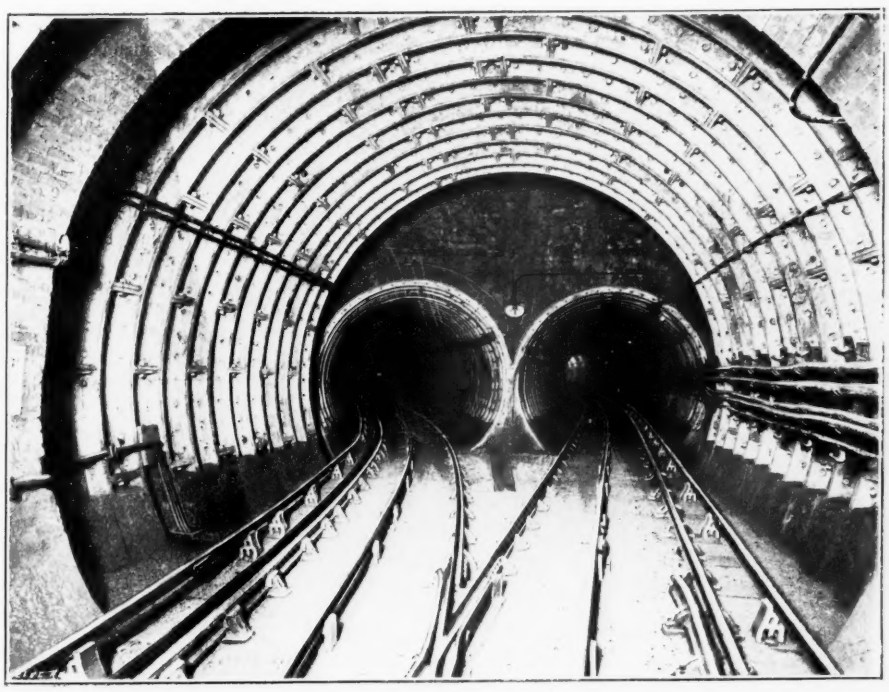


Fig. 2.—Tunnel Work, Hyde Park Cross-over.

Our view on p. 21 shows the above gradient with District Railway at the side, just beyond Baron's Court. In construction and equipment the new railway is standard, and practically duplicates the Baker Street and Waterloo Railway, the running tubes being 11 ft. 8 in. diameter and the station tubes 21 ft. 6 in. diameter, lined with cast-iron segments in the usual way.

The tunnels vary in depth from 20 ft. below the street level at Finsbury Park to 100-123 ft. between Russell Square and Piccadilly Circus and 60 to 70 ft. under the District

route: the usual curves adopted have a radius of 1,320 ft., but a sharp curve (330 ft. radius) was necessitated at the

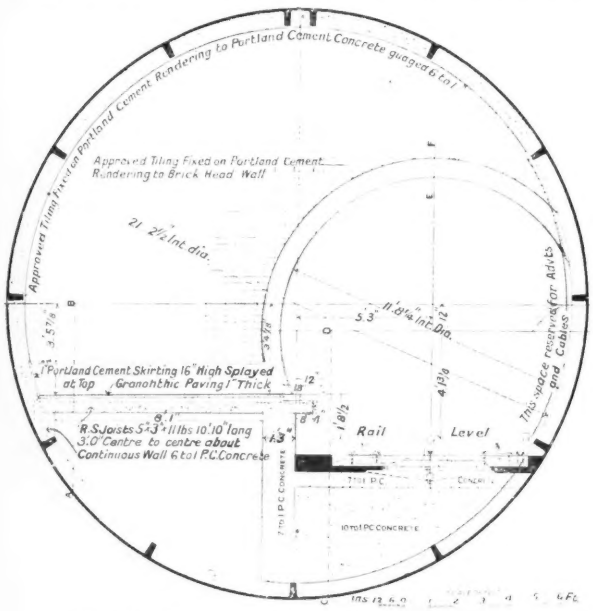

Approved Tiling Fixed on Portland Cement Rendering to Brick Head Wall
21' 2½" Int. dia.
11'8½" Int. Dia.
Rail Level
Portland Cement Skirting 16" High Splayed at Top
Granolithic Paving 1" Thick
R.S.Joists 5"x3"x11lbs 10'.10" long 3.0" Centre to centre about
Continuous Wall 6 to 1 P.C. Concrete
10 to 1 P.C. CONCRETE

Fig. 3.—Cross-Section through Station Tunnel.

entrance to the Holborn Station owing to following the route of the thoroughfare above. The steepest gradients on the route were constructed for retardation (1 in 66) and acceleration (1 in 33) at the entrances and exits of stations.

Car-sheds nearly a quarter of a mile long, and containing six tracks with inspection pits, are provided at Lillie Bridge; adjoining are extensive electrically driven repair shops.

The track construction is almost a replica of that on the Baker Street and Waterloo Railway. The permanent way is laid on 10 in. × 5 in. Karri sleepers, which are practically fireproof, spaced 3 ft. 4 in. apart, and provided with angle-irons on their under side, which, when embedded in the concrete foundation lining the bottom of the tube, are practically immovable. With a view to securing elasticity in the track, the ends of the sleepers carrying the running rails overhang the foundation, and with the running rails themselves are supported on crushed granite ballast. A 3-in. diameter drain is embedded in the concrete under the centre of the track, and connected with cross gutters at intervals, and sumps at the foot of each gradient. The concrete is carried up the sides of the tunnel in the form of a lining 2 ft. above the ballast, with a view to preventing accidental short-circuits between the collecting shoe and iron segments forming the tunnel, such as have occurred on the Baker Street and Waterloo line, where this was not done.

The track rails are of bull-headed section, weighing 90 lb. per yard, and are laid to the 4 ft. 8½ in. gauge; they are supported on ¼ in. of pressed wood felt in chairs of normal pattern, and fished together in the usual way.

The conductor rails are rectangular in section, and weigh 85 lb. per yard; the power rail is outside the running rail at the side of the tunnel, and the return rail midway between the track rails, both being supported on Doulton insulators, and bonded with flexible wire bonds.

The rails were all supplied by Messrs. Bolckow, Vaughan and Co.

The sectional views through the tunnel and track, for which we are indebted to the *Tramway and Railway World*, give a good idea of the construction used.

Energy for the operation of the line is obtained from the Lot's Road Power Station of the Underground Railways Co., which was fully described in the Electrical Review of June 9th, 1905, the turbo-generating plant there installed supplies three-phase alternating current at 11,000 volts and 33⅓ cycles to the District Railway sub-station at Earl's Court, and from the latter six cables (giving a duplicate transmission) are carried down a vertical shaft to the Great Northern, Piccadilly and Brompton tunnels below—three cables being bracketted to the side of each tube.

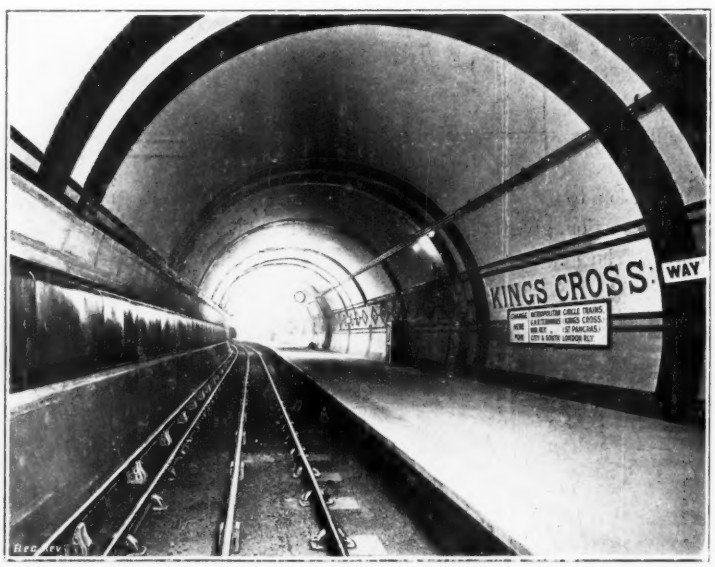


Fig. 4.—A Typical Tunnel Station: King's Cross.

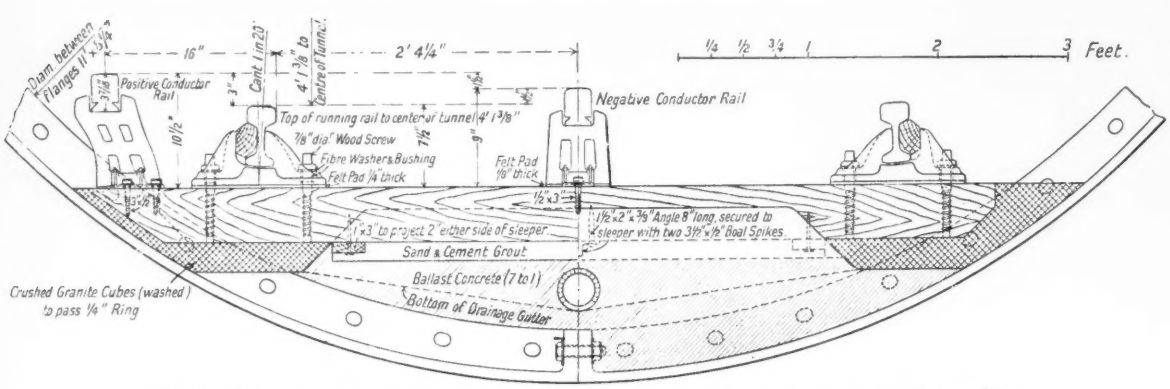

16"
2' 4¼"
Cant 1 in 20
4' 1 3/8" to centre of Tunnel
Positive Conductor Rail
Negative Conductor Rail
Top of running rail to centre of tunnel 4' 1 3/8"
7/8" dia. Wood Screw
Fibre Washers & Bushing
Felt Pad ¼ thick
Felt Pad 1/8" thick
1½"x3"
1½"x3" to project 2" either side of sleeper
1½"x2"x⅜" Angle 8" long, secured to sleeper with two 3½"x½" Boat Spikes
Sand & Cement Grout
Ballast Concrete (7 to 1)
Bottom of Drainage Gutter
Crushed Granite Cubes (washed) to pass ¼" Ring
Feet.

Fig. 5.—Section through the Trackwork, showing Arrangement of Running and Power Rails.

Three sub-stations are provided, situated at Hyde Park Corner, Russell Square and Holloway; the plant installed is exactly similar to that used on the District and Baker

Street and Waterloo Railways, comprising three 800-kw. rotary converters in the first, and two 1,200-kw. rotaries in the second and third named sub-stations respectively.

In addition there is the usual complement of single-phase transformers, switchgear, signal motor-generators and air compressors, &c., all supplied by the British Westinghouse Co.

The cables, both H.T. and L.T., the latter for energising the power rail at 550-600 volts, were supplied by the British Insulated and Helsby Cables, Ltd.

The stations are quite a feature of this, as of the Baker Street and Waterloo Railway, the buildings at street level, comprising the booking hall, &c, being executed in reddish-brown glazed bricks, which render them easily distinguishable; the station tunnels also are lined with coloured glazed tiles arranged in various patterns, with the same object. A view in the King's Cross station is given on p. 20. The Holborn station forms a junction with the branch leading to the Strand, a physical junction being made only with one tube, *i.e.*, that leading from Finsbury Park to Hammersmith, the other Strand tube having a dead end.

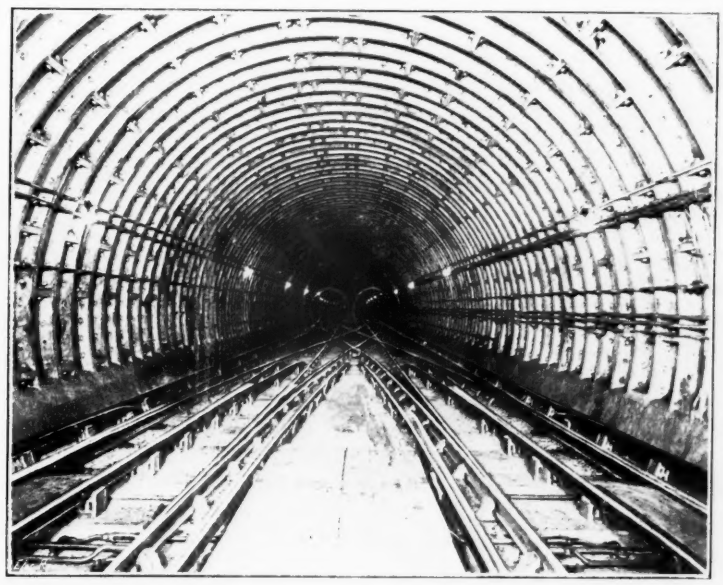


Fig. 6. The Long Scissors Crossing, Finsbury Park.

drawing some 18,500 cb. ft. of air per min. from the tunnels, to which they are directly connected by the ducts. In all 19 exhaust fans have been provided, driven in each case by a 10-h.p. motor.

The lift work has for the most part been carried out by the Otis Elevator Co., the exception being at Finsbury Park, where hydraulic lifts by Messrs. C. & A. Musker are installed, worked from an enlarged hydraulic plant, owned by the Great Northern Railway Co.

At Holloway Station an innovation has been introduced in the shape of a moving spiral conveyor, which is installed in place of a lift, occupying a lift shaft. This conveyor consists of an endless band, moving at a speed of 100 ft. per min. arranged in the form of an outer and inner spirals, travelling in opposite directions. The band consists of teak boards supported by steel chains, and it is provided with a flexible handrail: the passenger, of course, has to step on or off the moving conveyor when entering or leaving it.

Fig. 7.—Baron's Court Sidings, and Entrance to Tunnels.

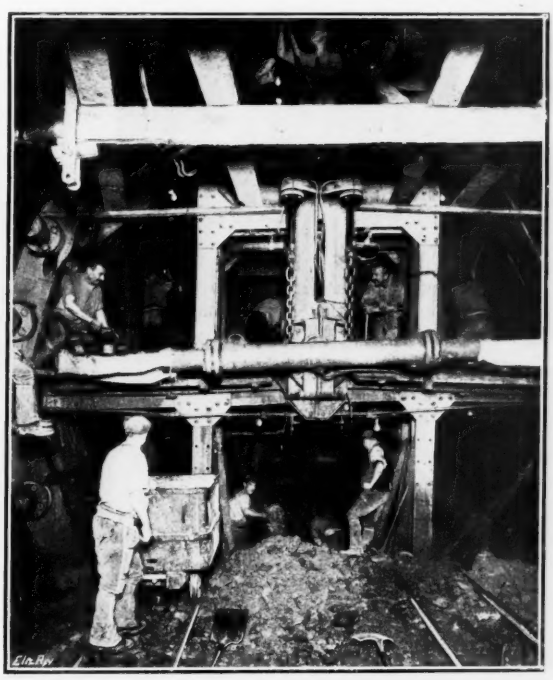


Fig. 8.—The Greathead Shield at Work: Strand Extension, G.N., P. and B. Railway.

It is understood that the Strand to Holborn section will be worked as a shuttle service.

Communication between the booking hall and platforms is maintained by both lifts and spiral stairways, the latter being provided for emergencies. Vertical ventilating ducts pass up the centre of the spiral stairways, and are connected to 5 ft. 6 in. dia. Heenan & Froude fans, each capable of

The apparatus was supplied by the Reno Electric Stairways and Conveyors, Ltd., as an experiment, and it is claimed to have a much greater capacity than a lift.

The electrical lift work is naturally a very important feature of this, as of other similar railways.

In all some 60 electrical lifts have been provided, ranging

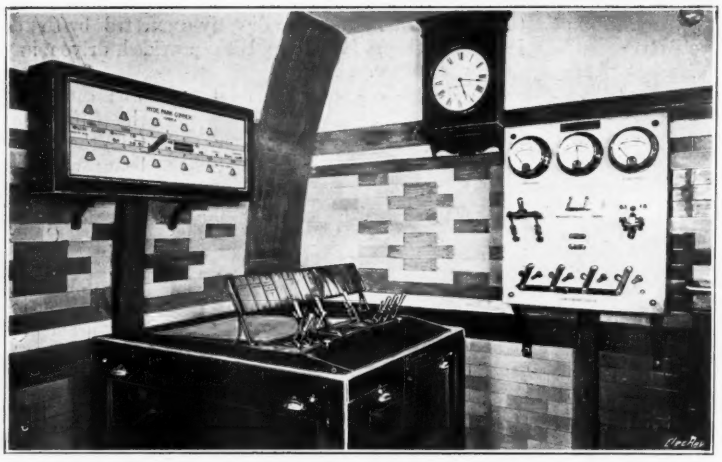


Fig. 9.—Signal Cabin, Hyde Park Corner, showing Switch Gear and Illuminated Diagram.

from two to five per station, according to probable traffic requirements.

The lift shafts are approximately 18 ft. in diameter and accommodate two steel cages; each of the latter has a nominal lifting capacity of 10,000 lb. at a speed of 200 ft. per min., and will comfortably carry 70 passengers.

The cages are each suspended by four $\frac{7}{8}$-in. diameter steel ropes, and are partially balanced by counter-weights suspended by similar ropes, the ropes passing over sheaves to the hoisting drum.

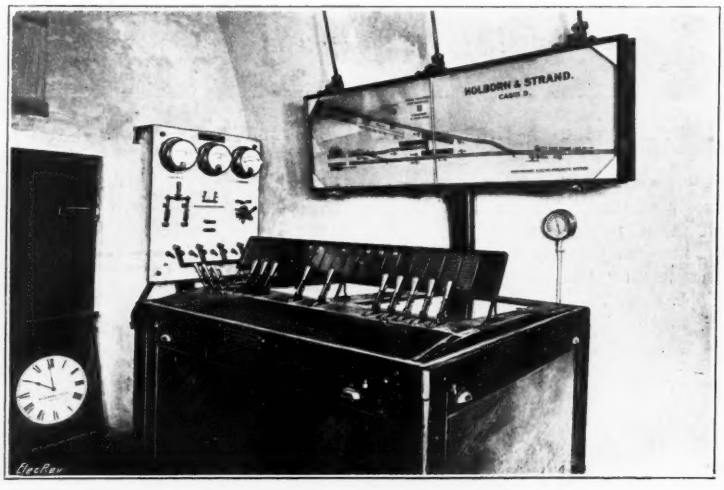


Fig. 10.—Holborn Signal Cabin D, controlling the Strand Junction.

Each cage is controlled by an Otis magnet controller, the switch handle being located near the entrance gate. Two independent control circuits are provided, viz., an ordinary working circuit and an emergency circuit. With the former, the movement of the controller handle has the effect of cutting in or out resistances by means of a series of magnetic switches mounted on a control board in the lift room. The emergency circuit enables the cage to be stopped by its attendant, who can operate either a safety switch or a special switch on his controller, which results in the short-circuiting of the hoisting motors. The over-running of the landings by the car would automatically bring into action limit switches securing the same end; and the sticking of the cage in the guides would bring into action a "slack cable" switch, with the same result.

The electrical winding gear is usually located over the lift shaft, and consists of a winding drum coupled at either end through worm gear to a 35-h.p. General Electric motor, with a speed of 625 r.p.m. These motors are run in series on special 575-volt circuits from the sub-stations; they are provided with three field windings, *i.e.*, a series field used in conjunction with the shunt running field when starting, and cut-out when speed is obtained; the running field; and a special stopping field.

In case of failure of the operating current the whole of the above field is automatically thrown across the armature as a low resistance shunt, and the motors becoming self-exciting, a powerful brake action is set up to rapidly retard the speed of the cage.

A powerful electro-mechanical brake on each worm shaft is brought into action by the limit switches as the cage nears the end of its travel, or through failure of the operating current, and excessive speed is guarded against by means of an Otis governor, which actuates a safety apparatus under the cage for gripping the wooden guides.

Oil buffers, with 5 in. dia. plungers with a stroke of 8 in., are also fitted under the cage and balance weight with a view to bringing them to rest without shock in emergencies, so that very completed provision has been made for safety in operation.

The lift attendent works his entrance gates by hand, and those for exit, on the opposite side, by compressed air supplied from the signal air mains. The exit doors on both upper and lower landings are similarly worked, although neither can be

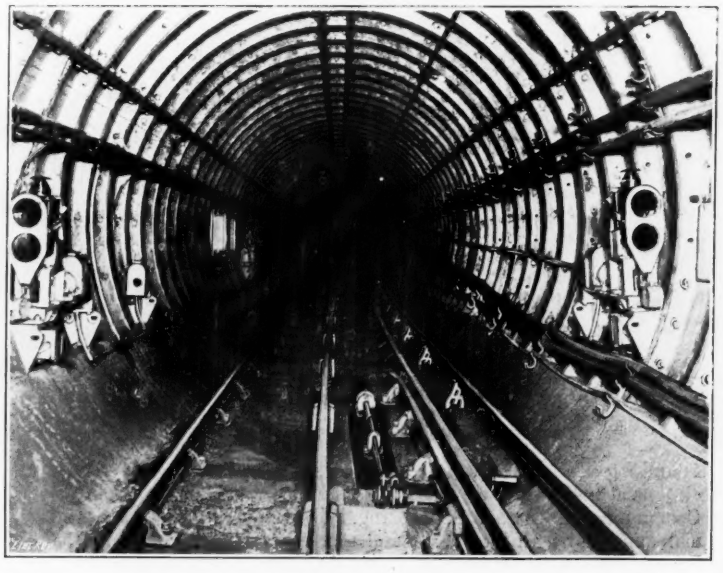


Fig. 11.—Showing Signals and Automatic Stop in Tunnel at Strand Junction.

opened unless the cage is within a few inches of its stopping position.

A reserve of compressed air is provided for emergency working in the shape of a 50-gallon reservoir in the bottom of the lift shaft.

Both the stations and tunnels are electrically lighted as usual in recent work of this kind; the Maxim arc lamp has been adopted for booking office and platform lighting as on the "Bakerloo" and District Railways, these lamps being fed from the lift circuits or as an alternative from the power rails in the tunnel.

Incandescent lighting is also provided in the stations, and the tunnels are continuously lighted by 16-c.p. incandescent lamps spaced about 40 ft. apart, and fed from transformers in the sub-stations, with alternating current at 220-volts pressure.

Any sub-station can supply the tunnel lighting throughout in case of need, and the local electric supply authority has been drawn on for supplying emergency incandescent circuits which are continuously in service at each station.

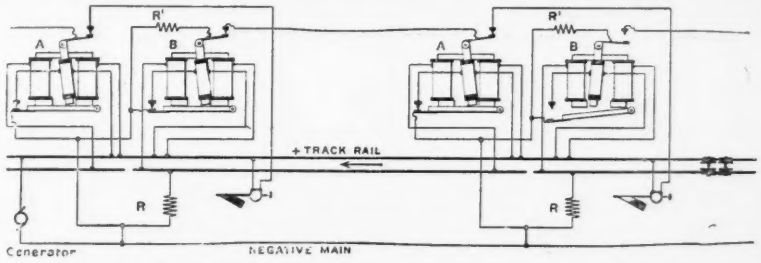
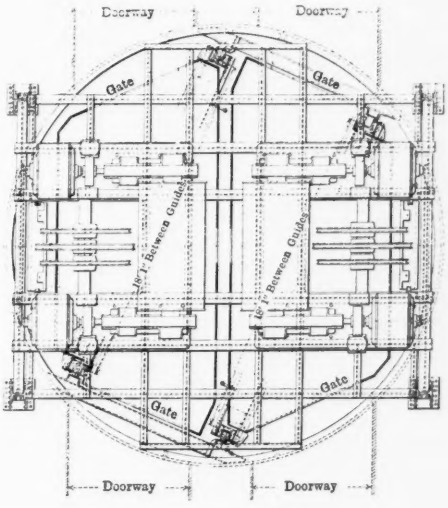


Fig. 12.—Diagram showing Westinghouse Automatic Signal System.

The Hammersmith station, as previously mentioned, is on the surface, and consists of three concrete platforms with steel roofs. Two running roads are provided, and they each end in single plunger oil buffer with a 17-in. diameter cylinder and 7 ft. stroke. These buffers are capable of



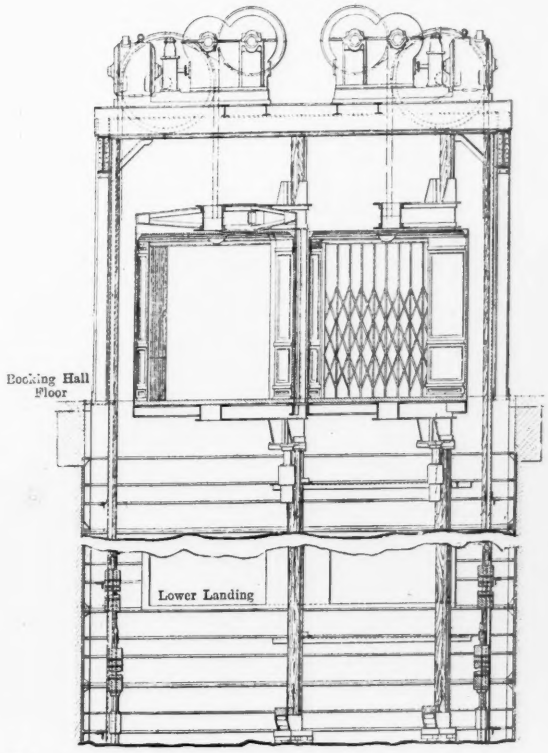


Fig. 13.—Plan and Elevation of Otis Electric Passenger Lift Gear installed at Stations.

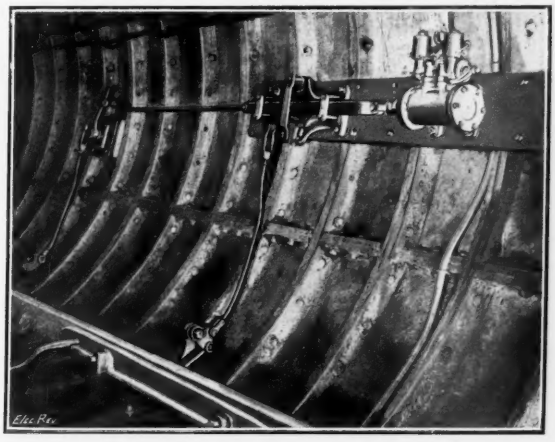


Fig. 14.—Electro-pneumatic Point Motor and Movement, in Tunnel.

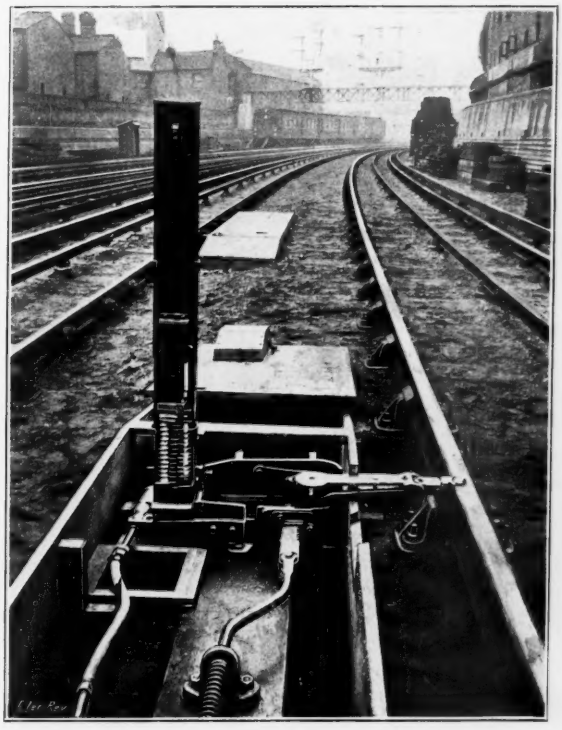


Fig. 15.—Automatic Magazine Fog-Signalling Apparatus, near Baron's Court.

pulling up a 200-ton train running at 10 miles per hour; the retarding force is constant, due to the automatic decrease of area of the orifices through which the oil has to pass as the plunger is forced in. These buffers were supplied by Messrs. Ransome & Rapier, Ltd., of Ipswich.

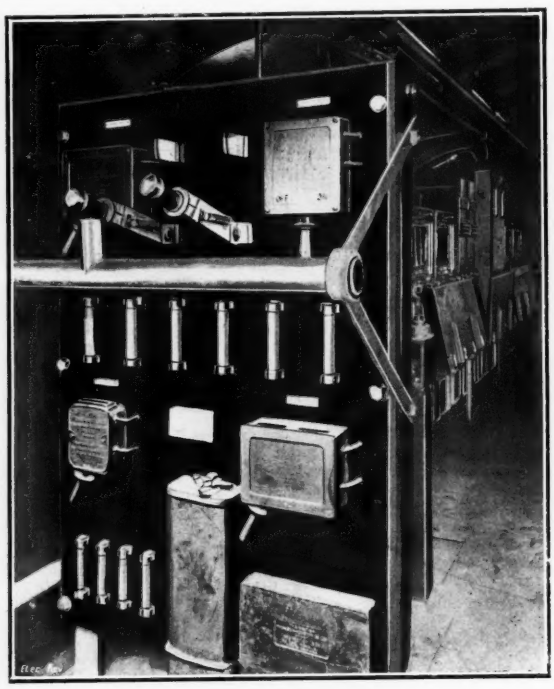


Fig. 16.—View in Driver's Compartment, Motor Coach, showing B.T.-H. Control Equipment.

A very complete system of electro-pneumatic signalling has been installed by the Westinghouse Brake Co., similar to that adopted on the District and the Baker Street and Waterloo Railways. In the through-running portions of the tunnels the signalling is entirely automatic, but where points have to be controlled from signal cabins, as at cross-overs and sidings, semi-automatic signals are installed.

The automatic signalling was described at length in the Electrical Review, June 2nd, 1905; compressed air at 65 lb. per sq. in., supplied from the sub-stations, is used to operate both points and signals, its entry to or release from the signal motors being controlled by track circuits with relays in series between the track rails, *i.e.*, the short-circuiting of the relays by a train in a section has the effect of putting the signal behind the train (which stands normally at "line clear") to "danger." The electrical supply for energising the apparatus is derived from a negative cable running the whole length of the line and supplied from the sub-stations, a pressure of 60 volts being maintained between this cable and the positive running rail.

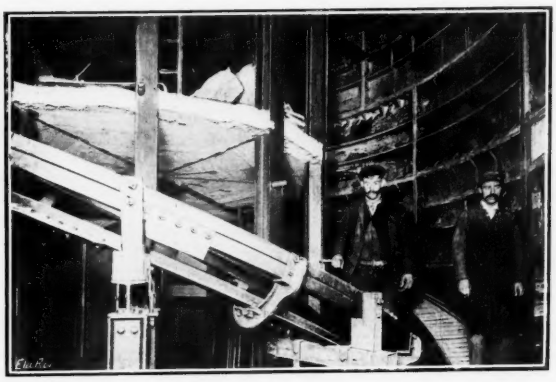


Fig. 17.—The Spiral Moving Stairways, Holloway Station.

This supplies power for the track circuits, for charging the accumulators at the power-worked interlockings and for working all relays, special circuits and other purposes, the power required for the track circuit being about ·3 kw. per mile of single track.

Both the signals and point motors and movements are fixed

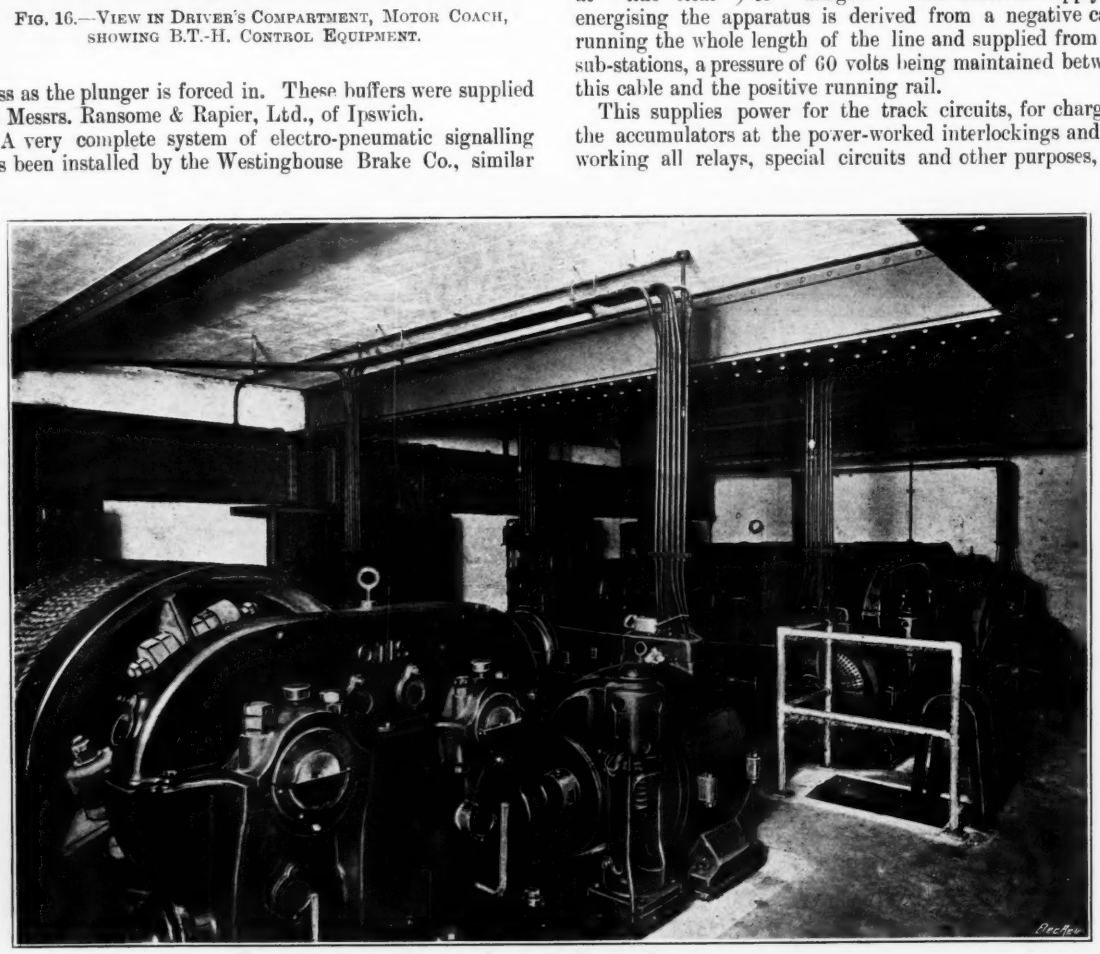


Fig. 18.—The Lift Room, Piccadilly Circus, showing the Otis Hoisting Gear, &c.

to the side of the tunnel, owing to the cramped accommodation, as shown on pp. 22 and 23.

The working signal cabins on the tube section of the railway are only two, *i.e.*, at Holborn and Finsbury Park, but emergency cabins for working cross-over roads are provided at Hyde Park, Covent Garden and York Road, and at Barons Court and Hammersmith the District Railway cabins are used jointly. Typical views of cabins are given on p. 22.

An electro-pneumatic locking frame, with its complement of miniature signal and point levers, an illuminated train diagram, a set of accumulators and controlling switchgear, &c., are installed in each cabin. Conflicting signals are divided into groups controlled by one lever, and the selection of a signal in a group is dependent on the position of the points

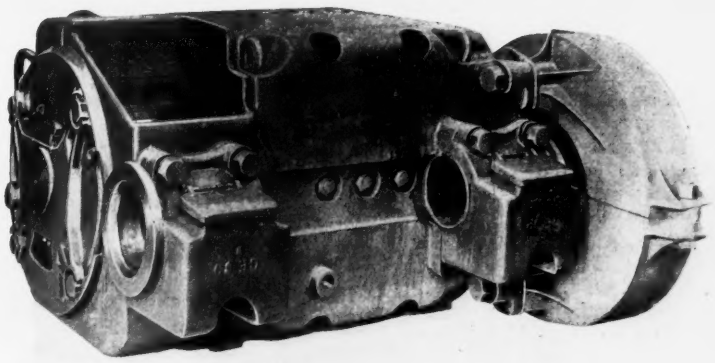
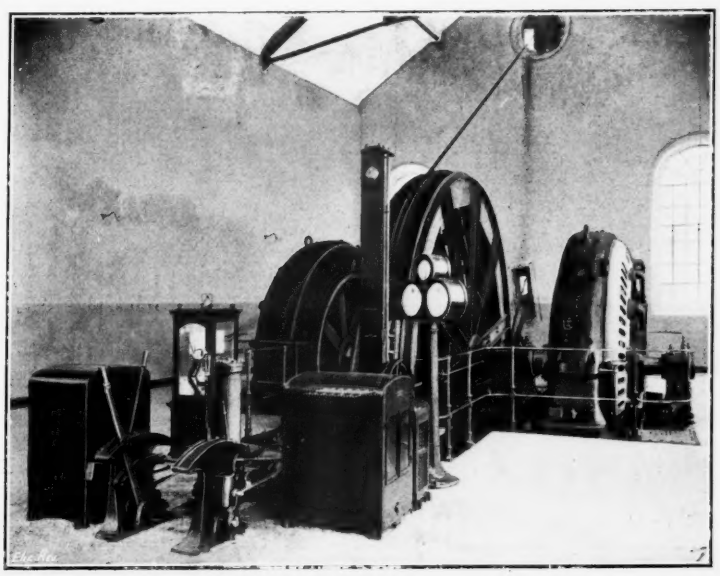


Fig. 19.—Standard 200 H.P. B.T.-H. Motor, adopted on G. N., P. and B. Railway.

The movement of a point lever is accompanied by an indication (*i.e.*, the release of an electrical lock) that the operation has been completed; a similar arrangement obtains in the case of signal levers when a signal has to be restored to danger—in order to indicate that the signal has actually returned to danger—although owing to the automatic action of the train in throwing its rear signal to danger immediately, the signalman can usually replace his lever in one stroke.

As a rule there are no distant signals, but repeater signals with yellow in place of red lights are provided in situations where the view of the ordinary signal is obstructed. Adlake long-burning oil lamps are provided to all signals, and the automatic train stop, familiar on the District, is also installed at each stop signal.



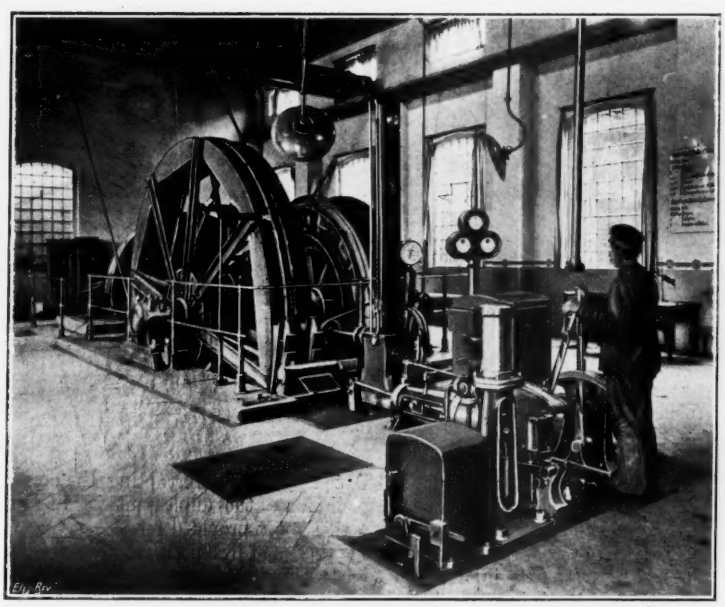
Main Hauling Engine, De Wendel Pit, Hamm, Westphalia. (See page 27.)

A particularly interesting feature of the signal cabins is the illuminated train diagram shown on p. 22; the various roads correctly sectioned, boxes, points, signals, &c., are painted on glass which is opaque except for the roads. Three electric lamps are arranged behind each road section in the diagram, controlled by the track circuit relays, and are always alight except when a section is occupied by a train.

The sections on the diagram are correspondingly lettered to the various levers controlling signals and points on actual sections, and the signalman thus has accurate knowledge and control of the traffic in his vicinity.

Some idea of the capacity for dealing with traffic which such an installation gives, can be gathered at the Hammersmith cabin, where 40 trains and upwards per hour are dealt with by one man, who may have on his illuminated diagram, four running trains on parallel lines, and others in sidings. Altogether 84 automatic stop signals, 72 semi-automatic, and 37 repeater signals are installed, the sections being arranged for a 1½-minute headway.

The points differ from the signals in that they require power for movement in either direction. In the case of facing points, the switches, plunger and locking-bar are all operated by one motor, the completion of the



Winding Engine, Mansfeld Copper Mining Co., Eisleben. (See page 27.)

operation, as previously mentioned being indicated to the signalman.

An innovation in the way of fog signalling apparatus has been introduced on the new line near Baron's Court, consisting of an adaptation of the Clayton fogging apparatus, operated by a compressed-air motor, as in the case of the automatic stops.

Its general appearance will be gathered from our illustration, in which the arm for automatically conveying the detonators from the magazine on the left to the rail, and returning the empty clips, can be seen. In action, a whistle connected to the air main, gives warning if the supply of detonators in the magazine is exhausted, or if the magazine happens to be removed from any cause.

The rolling stock on the new railway includes 72 motor-cars, each equipped with two motors, and 146 trailers, 216 of this number were supplied from the Continent and the remaining two by British makers.

In design the cars resemble the Baker Street and Waterloo coaches, but have a better finish, and a more serviceable colour outside, viz., lake.

Steel has been employed almost wholly in their construction, the exception being certain non-inflammable panelling; the seats are of the familiar rattan cane.

Each motor-car will seat 42 passengers and each trailer 52, the former weigh 27½ and the latter 16½ tons; three coach trains will be used in the first instance.

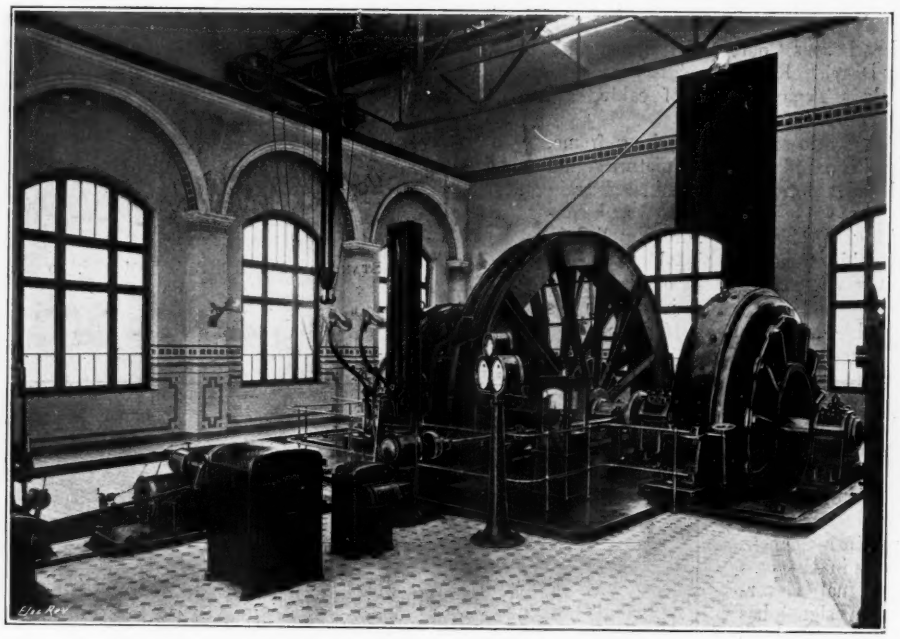
The electrical equipments, as in the case of the District and Baker Street and Waterloo Railways, have been supplied by the British Thomson-Houston Co. These consist of the standard type G E 69 200-H.P. motors and Sprague Thomson-Houston control; for a complete description of the motors and control system we must refer readers to Vol. 49, p. 973 of the Electrical Review.

The master controllers are equipped with the so-called "dead man's handle," which ensures that in the event of the motorman removing his hand from the controller from any cause, the power will be cut off and the brakes applied automatically.

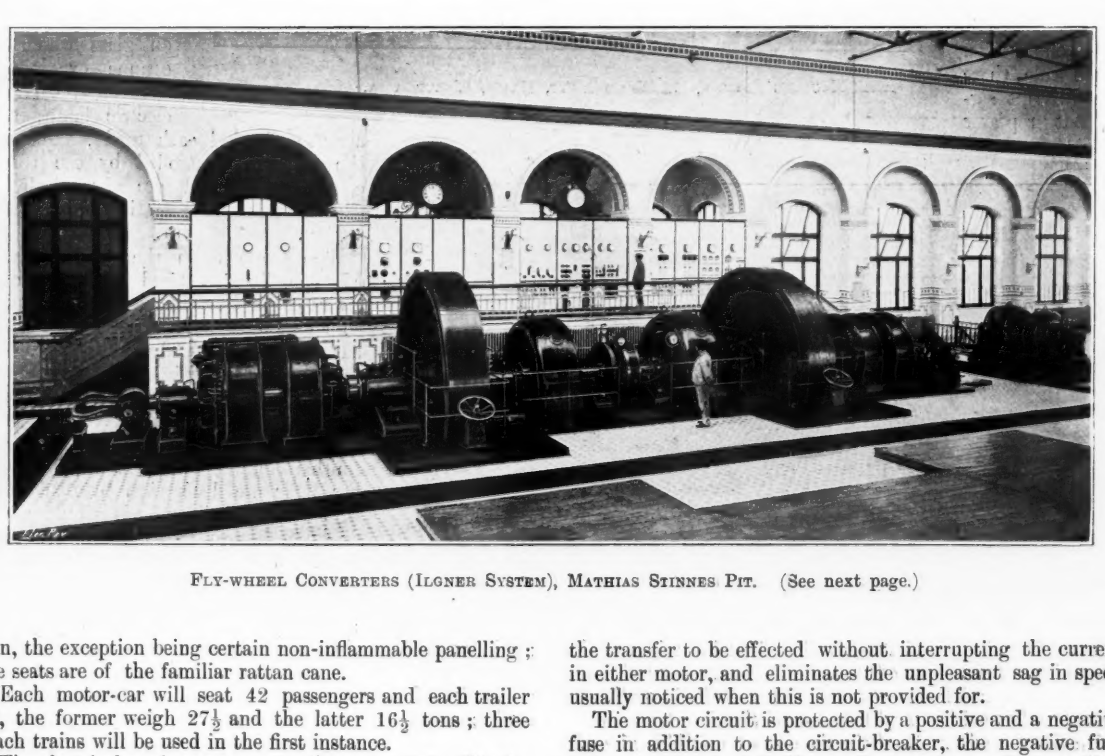
The bridge method of changing from series to parallel combination of the motors, adopted in these trains, allows the transfer to be effected without interrupting the current in either motor, and eliminates the unpleasant sag in speed usually noticed when this is not provided for.

The motor circuit is protected by a positive and a negative fuse in addition to the circuit-breaker, the negative fuse being considered advisable, as the negative conductor rail is not earthed.

All the control apparatus, as well as the air compressors,



Main Winding Engines, Mathias Stinnes Pit, Carnap, Westphalia. (See next page.)



Fly-wheel Converters (Ilgner System), Mathias Stinnes Pit. (See next page.)

is carried in a steel cab at the driving end of the car. Here the contactors and circuit-breakers are hung from horizontal slate panels, supported by rigid steel framework, as shown in our illustration page 24. This form of construction was adopted because the small diameter of the tunnel does not allow sufficient room for the apparatus to be carried under the car, as in the case of the District Railway. It is also considered safer on the tube lines to have the apparatus enclosed in a steel cab, in case of any fault developing in the equipment while a train is running in the tunnel.

In addition to the passenger stock, there are two accumulator locomotives, which were originally used in the transport of excavated material from the tubes during construction (Electrical Review, Vol. 57, p. 638), and are now employed for shunting purposes.

In conclusion, we may note that the journey from Hammersmith to Finsbury Park is timed to occupy 38 minutes; the average speed being 15 miles, and the maximum speed 25 miles per hour.

Graduated fares, season tickets and through bookings with the Great Northern, Midland, Baker Street and Waterloo, and District Railways, and London United Tramways, are features of the new tube, which the promoters intend shall lack nothing in attractiveness to the travelling public.

Mr. Jas. R. Chapman is the chief engineer of the Underground Electric Railways Co. of London; to him and his assistants, Mr. G. Rosenbusch and Mr. C. E. Strange, we are indebted for information supplied.

Our half-tone views, with the exception of figs. 14, 16 and 19, were prepared from photographs taken by Mr. G. Marshall Smith.

ELECTRICALLY-OPERATED MAIN WINDING MACHINES.

[By Our Berlin Correspondent.]

In view of the ever-increasing favour met with by electrical operations in mining, a description of a few winding plants operated on the Ilgner-Siemens-Schuckert system is of interest at the present time.

On the facing page we illustrate one of the two main pit winding engines installed at the Mathias Stinnes Mine, near Carnap, Westphalia, for an output of 100 tons per hour with a depth of 500 metres, which, however, is to be increased eventually to 800 metres. The useful load for each run is 4,800 kilogrammes and the maximum speed of winding 14 metres per second. Fly-wheel converters fed from the Rhenanian-Westphalian Electricity Works (situated 9 kilometres distant) serve to operate all four machines. The fly-wheel converter plant provisionally comprises two converters coupled together, each of which consists of a fly-wheel, a three-phase motor and two dynamos.

Owing to the impossibility of concentrating the fly-wheel mass required for compensating the load of one machine, in a single fly-wheel, two fly-wheels each of 43 tons weight have been provided. These together compensate for any fluctuations in the load of a winding engine, being coupled to the motor-generators of both winding engines. Whenever the two winding engines start simultaneously at full-load (in which case the fly-wheel masses will be insufficient) a convenient loading up is ensured by interlocking the the controlling lever for a partial movement, by means of a locking magnet arranged in the controller of the winding plant. The winding speed then reaches only half its normal value, the fly-wheel masses being allowed sufficient time to reach their proper speed.

In addition to the two winding engines above mentioned, there have been installed two others, which at present are connected only in emergencies to the existing double fly-wheel converter. As soon as these machines are taken into regular operation, another fly-wheel converter of exactly similar design will have to be provided. In order, then, to further equalise the amount of energy required for the four winding engines, two steering dynamos have been provided for each of the latter, their connections being such as to enable either (voltage variation) dynamo of a double fly-wheel converter, in the event of all the four machines being operated, to be connected up in series with another on the other converter. The four large fly-wheels will then be coupled together both electrically and mechanically.

On p. 25 is represented the main pit hauling engine of the De Wendel mine, near Hamm, Westphalia. The output of this machine is 175 tons per hour, the depth of pit being at present 750 metres (to be increased to 900 metres), the useful load each run 5,200 kilogrammes and the maximum speed of winding 18 metres per second.

This plant has been designed on a similar plan to the above, but there is only one hauling machine and one motor-generator installed at the present moment. However, two fly-wheels, of 43 tons weight each, were installed from the beginning in order to compensate for the variations in load.

In the case of the main pit winding engine of the Mansfeld Copper Slate Mining Co., at Eisleben, the output is 95 tons per hour with a depth of pit of 330 metres (to be increased to 575 metres), a useful load of 2,200 kilogrammes, and a maximum winding speed of six metres per second (to be raised to 12 metres per second).

The main pit winding engine of the Lahrisch-Mönnich Mining Superintendence, at Karwin, Austria, is a final example. This machine is worked with a depth of pit of 530 metres, an output of 125 tons per hour, a useful load of 3,050 kilogrammes, and a maximum speed of winding of 12 metres per second.

LIGHTING and POWER NOTES.

(*Concluded from page* 18.)

Southport.—The Electricity Committee's operations during the past year resulted in a gross profit of £14,710, against £14,771 last year, and a net profit of £3,375, against £3,355. The total income of the estate for the year 1905-6, was £23,659, compared with £22,593 in the previous year. The expenditure amounted to £20,283.

Standish-with-Langtree.—It is notified in the *London Gazette* that the B. of T. has revoked the E.L. Order, 1901, as from December 21st last.

Watford.—A L.G.B. inquiry was held last week into the application of the U.D.C. for a loan of £13,500 for E.L. purposes. The inspector said he should want particulars showing how the last loan of £25,000 had been expended, and referring to the fact that the capital charges per unit continued to increase, and remarked that the undertaking was not in a very healthy condition. The inquiry was adjourned *sine die* for the particulars asked for to be given.

TRAMWAY and RAILWAY NOTES.

Australia.—New South Wales.—It has been agreed to construct an electric tramway from George Street, near the Sydney Harbour Station, to Erskineville at a cost of £10,000. The West Maitland and District Hill Electric Tramway and Bellevue Hill Bills have passed the third reading.

Victoria.—Messrs. Noyes, in their report on the proposed electric tramway to St. Kilda, estimate the cost at £72,000 with "sleeper" and £56,000 with concrete construction, and that there would be a saving of £2,800 if arrangements were made with the proposed Prahran-Malvern tramway for a joint power house.

Blackpool.—The Corporation tramway service on Boxing Day had to be abandoned up and down the promenade. A very severe snowstorm raged during the holidays, and we learn that the Fleetwood tramroad was snowed up also, the company's cars being similarly stranded.

Continental Notes.—Belgium.—A new electric tramway between Ixelles and Schaerbeck, near Brussels, was put in operation on the 1st inst.

Italy.—The *Globe* reports that as an electric train was entering the station at Gallarate, Lombardy, on the 27th ult., it collided with another train standing on the line. Several coaches were much damaged, and about 30 passengers were injured, many of them seriously.

Croydon.—The first seven months' working of the Croydon Corporation Tramways Employés' Sick Benefit Society, of which the tramways manager, Mr. T. B. Goodyer, is the president and treasurer, has been very satisfactory. The total receipts have amounted to £175 13s. 4d., while £24 15s. has been paid out in sick pay, £21 19s. 8d. in medical officers' fees, £3 15s. 8d. to members leaving the service, £9 7s. for death grant to member's wife, and £9 19s. 5d. incidental expenses, leaving a share-out of 12s. 4½d. per member (seven months). It has been decided to increase the contributions from 7d. to 1s. 1d. per week (1s. ordinary, and 1d. medical attendance), and the sick pay to 20s. per week for the ensuing year, and, as 160 members have been enrolled, even more satisfactory results are looked forward to during 1907.

East Ham.—The snow is given as the cause of a Corporation car skidding and leaving the track on the 28th ult. The car ran on to the pavement, and crashed into a draper's shop.

Glasgow.—The Tramways Committee has again decided to construct a line to Thornliebank, in order to relieve the pressure on the Ronken Glen route. The recommendation was originally sent back for further consideration when it first came before the T.C.

The general manager of the tramways submitted a scheme for connecting the tramways power station at Pinkston and the Port Dundas station of the electricity department, and the Committee agreed to recommend that the scheme be approved, and that the work be proceeded with. It was remitted to a Sub-Committee to consider and report on the question of providing at the power station, Pinkston, additional generating plant.

The general manager submitted to the Corporation Tramway Committee a report on the danger of allowing cylinders containing charges of gas, for use in connection with limelight entertainments, to be carried on the cars, and also a relative report thereon by the city analyst, and the Committee, after consideration, was of opinion that the carrying of these cylinders on the cars should be discontinued.

The Tramways Committee, in order to meet the ever-increasing requirements of the system, has recommended the building of a hundred new cars. They will be built at the Corporation works, and will be turned out at the rate of two per week.

Haslingden.—The T.C. has resolved to give notice to the Accrington Steam Tramways Co. that at the end of six months, as from January 4th, 1907, it will exercise its powers to purchase that portion of the company's undertaking which is in the borough. It is proposed to electrify the undertaking after the purchase.

Leyton.—The surveyor, the electrical engineer and the tramways manager are to report upon proposals for tramway junctions with the Walthamstow system, and are also to prepare an estimate of the cost of the proposed work.

Liverpool.—Mr. Mallins, traffic manager of the Liverpool tramways, recently invented an improved appliance for use with electric cars, as an auxiliary device for sanding rails when slipping, or to enable a driver to effect an emergency stop, whether a car be travelling forwards or backwards. The apparatus in question has been patented, and the Liverpool Tramways Committee has decided to have 50 cars fitted with it. The chief features of the apparatus consist in the use of an auxiliary hopper to contain sand, and of a system of levers and rods, by means of which a driver may, at will, cause a more copious supply of sand to fall on the rails, than an ordinary sand-box yields. The auxiliary hopper is fixed so that its delivery tube shall be within a few inches of the rim of the wheel, the tube of the ordinary sanding supply being fixed a little farther from the wheel. The two supplies of sand are controlled by one small foot-lever. The auxiliary sand supply of the rear wheels of the car can also be brought into play without the driver's having to leave his platform, in the event of a car from any cause beginning to move backwards when ascending a hill. In tests made at Liverpool, on greasy rails, a car, when travelling at 12 miles an hour, was stopped in 3 yds. by using sand from the auxiliary supply, whereas by the ordinary supply the car could only be stopped in 15 to 20 yds.

London.—Great Western and Metropolitan Railways.—The daily Press recently reported that, owing to the heavy snowstorm last week, it became necessary to run some trains by steam power for a few trips in the early morning.

L.C.C.—It appears that the snow last week gave the tramways department considerable trouble, their various services being many times disorganised.

A car, on the 28th ult., left its appointed path for the pavement, and demolished a lamp. The plough, of course, remained in the track and obstructed the traffic. The *Standard* says that last week the spectacle of vivid flames beneath a car, which was enveloped in black smoke, attracted much public attention, and we learn that "similar accidents occurred on two or three other occasions" during the time of snow.

According to the *Tribune*, the County Council is making arrangements for the erection of a sub-station at Loughborough Junction, at an estimated cost of £80,000. This will provide additional service on the existing lines, at present curtailed owing to an insufficient supply of energy. The temporary iron structure, built at Loughborough about three years ago for the purpose of a local electric supply, is being offered for sale, while the machinery connected therewith has been disposed of.

The isolated section of the C.C. tramways along Commercial Road to Poplar, which has quite recently been opened for electric traction, had, on the 31st ult., to be operated by a horse service again. The electric service was being operated from a sub-station at Limehouse, not yet properly equipped, and the temporary plant in use broke down.

London United.—The London United Tramways Co. is seeking Parliamentary powers to construct a subway for foot passengers between the approach to the Great Western and Metropolitan station and the Metropolitan District station at Hammersmith. It is to be completed within five years. The Bill also contains clauses in which the company asks that the time for the completion of the tramways under construction shall be extended to 1909.

Waterloo and City Railway.—It was reported that as from January 1st the Waterloo and City Railway would be taken over entirely by the L. & S.W. Railway Co. Since it was opened in 1898 the L. & S.W. Railway Co. has operated the line for a certain proportion of the receipts, stated not to exceed 55 per cent. Little alteration in the working, we understand, will take place at present.

Metropolitan District Railway.—We understand that the company has decided to run its short trains at more frequent intervals between Ealing, Hounslow, Richmond and Wimbledon and the City. It is reported that in busy hours cars will leave South Kensington for the City every 2½ minutes.

Manchester.—The late snowstorm seriously affected the working of the tramways. The task of clearing the lines of the heavy mass of snow which fell on Wednesday and Thursday last week was enormous. Before anything was done in this direction on Wednesday morning, a number of cars left the sheds with the expectation that they would be able to force their way through the streets. Some of them got into snowdrifts, and had to be dug out—not without injury. Some 30 or 40 were taken into the sheds, in the course of the day, with damaged resistances. The traffic receipts fell seriously, whilst working expenditure was largely increased: and at the end of Christmas week it was found that, for the first time during the year, the income of the Department was exceeded by the outlay. But it appears that, for the calendar year, the fares have yielded £50,000 more than in 1905, so that a single week's loss does not spoil the record. In previous years it has not been unusual for several weeks to show a loss on the working.

Rochdale.—The cost incurred in the acquisition and construction of the tramways in the borough totals £350,720, made up as follows:—Acquisition of the old steam tramways from the Bury, Rochdale and Oldham Tramways Co. cost £80,208, including £4,771 loss on the working of the old steam system; £137,492 was expended on electrifying the system, and £133,023 for other purposes in connection with the undertaking. The Tramways Committee has decided to place the loss incurred in working the steam tramways to the tramways revenue account, and to apply to the L.G.B. for sanction to borrow £35,023 for tramway purposes.

South Africa.—Johannesburg.—The first serious accident on the municipal tramways happened on December 5th, near midnight, on the Yeoville section. A car containing eight or nine passengers, when travelling at a good speed, jumped the rails on a curve and completely overturned. The majority of the passengers were severely bruised and received numerous contusions, while four, including the driver and conductor, were more severely injured.

South Lancashire.—The South Lancashire Tramways suffered a good deal from the late snowstorm. In the Leigh and Atherton district, particularly, inconvenience and delay were experienced. Numerous cars were embedded in the snow, and on Christmas night at Atherton, half-a-dozen stranded passengers had to spend the night in a waiting room. Miners and mill-workers, who depend on reaching their work by car, suffered great loss.

It was expected that the company's last link in the Manchester district, viz., from Newtown, Pendlebury, to Unity Brook, Kearsley, would be completed with the dawn of the New Year, but the severe weather experienced of late has retarded the work.

The Simplon Tunnel.—In a letter to the *Morning Post* of December 25th last, Mr. Francis Fox writes on behalf of the Government Railway Department of Switzerland as follows:—"Since the commencement of the great work of the piercing of the Alps by the Simplon Tunnel paragraphs have appeared in various London papers, emanating from a Swiss source, stating from time to time that the tunnel, owing to the unprecedented difficulties encountered in its construction, was to be abandoned. Whether from rivers of cold water, hot springs, difficult ventilation, or falling of rock, the work was impossible. Notwithstanding these ominous forecasts the work has been successfully accomplished, but even this does not stop the pen of this correspondent. He has lately written to say the heat is insufferable, the ventilation is imperfect, the arch is being crushed, and the permanent way displaced. I am instructed by the Railway Department to contradict once and for all these statements. The railway tunnel through which the trains pass is in perfect condition, the ventilation excellent, and the comfort of the trains all that can be desired."

York.—The Tramways Committee of the Corporation has passed a resolution recommending the City Council to refuse consent to the promoters of the York and District Tramways Bill, 1907, for laying down any tramways in the city, and that, if necessary, a memorial be lodged in Parliament, complaining of the non-compliance with Standing Orders.

Wolverhampton.—The Lorain surface-contact system of electric traction has during the recent frost and snow disappointed its advocates, for whilst outside the borough the overhead cars have never ceased to run, the Lorain cars within the borough—or, at least, many of them—have not been able to cope with the wintry elements. Snow commenced to descend on Christmas Eve, the fall being succeeded by a severe frost, and on the evening of Christmas Day there was again another heavy downfall of snow. By arrangement the cars did not run on Christmas Day, the men receiving a day's holiday as well as a day's pay; but on Christmas evening a number of the officials turned out with the object of getting the lines cleared and in readiness for the Boxing Day traffic. Their efforts, however, were almost unavailing, so firm a hold had the frost on the track. For a portion of Boxing Day the lines to Willenhall, to Bilston, and the Whitmere Reans were open; but the traffic was conducted with great difficulty. The lines to Tettenhall, to Wednesfield, and to Bushbury, however, were not opened until Friday, and during the whole of Wednesday and Thursday, and on Friday morning, men were busily at work with spades, shovels, &c., clearing the track and contact boxes. The section from Newbridge to the extremity of the Tettenhall line was not opened until Saturday evening, so that at no time from Christmas Eve till Saturday were the whole of the tramways within the borough open for traffic. Obviously, there must have been a very serious loss of revenue, and there must also have been a very considerable amount paid for clearing the track. Several indignant letters have appeared in the local Press.

TELEGRAPH and TELEPHONE NOTES.

Milliplex Telegraphy.—News comes (from America, of course) of a new telegraph system by which a thousand messages can be sent, at the same time, in each direction, over a single wire. The inventor, a young Italian, says that the system will also be applicable to wireless telegraphy, by which it will be possible to send in each direction 20 messages at the same time.

Truly wonders never cease! The inventive genius of the modern Press agency is astounding.

Post Office Servants' Grievances.—A report from the Select Committee appointed to inquire into the wages and position of the principal classes of Post Office servants was issued recently. As it was not possible to make a full report in the past session, it is recommended that a committee on the same subject be appointed in the next session of Parliament.

Post Office Telegraphs.—The daily Press on January 1st dealt at considerable length with the impending retirement of the popular Engineer-in-Chief to the Post Office, Mr. John Gavey, C.B., which, it is stated, will take place before August next, when the age limit is reached. It was only in 1902 that Mr. Gavey succeeded to the distinguished post in question; his more recent achievements include the laying of the underground telegraph cables and the establishment of the Post Office telephone system in London, but, of course, these form only a small part of the work that has been accomplished under his supervision.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Trinidad-Demerara (No. 1.)	Aug. 26, 1901	..
Paramaribo-Cayenne	Nov. 27, 1906	..
Cayenne-Pinheiro	Aug. 13, 1902	..
St. Lucia-Martinique	May 7, 1902	..
Dominica-Martinique	May 7, 1902	..
Guadeloupe-Martinique	Aug. 29, 1906	..
Mole St. Nicholas-Port au Prince	Aug. 16, 1906	..
Curacao-Coro, Curacao-La Guayra, Curacao-Maracaibo	Closed.. Jan. 12, 1906	..
Reissa-Issa and Reissa-Yemani (Yemen)	Oct. 22, 1902	..
Tarifa-Tangier	Jan. 18, 1904	..
Port Arthur-Chifu (Closed)	Mar. 9 1904,	..
Garachico-Santa Cruz	July 12, 1906	..
Las Palmas-Arecife	Aug. 18, 1906	..
Guantanamo-Mole St. Nicholas	Nov. 22, 1906	..
Mole St. Nicholas-Cap Haytien	Nov. 22, 1906	..
Gibraltar-Tangier	Dec. 3, 1906	..
Fao-Bushire	Dec. 4, 1906	..
Tenedos-Salonica	Dec. 16, 1906	Dec. 24.
Martinique-Paramaribo	Dec. 17, 1906	..
Trinidad-Demerara (No. 2.)	Dec. 18, 1906	Dec. 29.
Landlines.		
Puerto-Barrios	Aug. 28, 1902	..

Wireless Telephony.—A correspondent states that the recent experiments in wireless telephony carried out between the offices of the Berlin Wireless Telegraph Co. and the Wireless Station at Nauen are claimed by the experimenters and their supporters to solve definitely the problem of wireless telephony. Prof. Slaby asserts that he and Under-State-Secretary Endow, who were present at the offices during the experiments, put the system to some very difficult tests, from which it emerged with absolute success. Columns of figures were transmitted with complete accuracy, and words which are considered very difficult phonetically, were put into specially constructed sentences. For instance, the word "Reichstagschluss," which causes trouble even on an ordinary telephone, was quite distinctly transmitted.

We are bound to admit that this is a crucial test; we commend it to our readers for practice.

CONTRACTS OPEN and CLOSED.

OPEN.

Australasia.—January 14th. According to *Australasian Hardware and Machinery*, tenders are being invited for telephones (9,000), magneto wall sets, for the Postmaster-General's Department, Commonwealth of Australia. Specifications, &c., at the Offices of the Deputy Postmaster-General, Sydney, Melbourne, Brisbane, Adelaide, Perth and Hobart. Tenderers to state name of country in which telephones will be made. Deposit, 5 per cent. on the amount up to £1,000, and 2½ per cent. on any further amount in excess of £1,000. Tenders to Deputy Postmaster-General, Melbourne.

Bridlington.—January 19th. Pumping machinery for the Corporation waterworks. See "Official Notices" November 30th.

Derby.—January 19th. Water-tube boiler, &c.; economisers; induced draught plant; coal bunkers, conveyors, &c., for the electricity department. See "Official Notices" to-day.

Dublin.—January 29th. The Dublin Port and Docks Board requires tenders for electrical pumping machinery and electric wharf cranes. Particulars from Mr. John P. Griffith, engineer to the Board, East Wall, Dublin, on payment of £1.

Iceland.—March 31st. The Reykjavik Town Council is open to give a concession for the supply of electrical energy and gas. See "Official Notices" December 7th.

Islington.—January 24th. Tenders to the B.C. for an electrically-driven capstan. See "Official Notices" to-day.

Launceston (Tasmania).—January 21st. Three-phase motors for one year. See "Official Notices" December 7th.

London.—January 23rd. The Metropolitan Asylums Board is inviting tenders for telephone and bell installation at the North-Eastern Fever Hospital. See "Official Notices" to-day.

L.C.C.—January 22nd. Thirteen induction motor-generators of 500 kw., and four of 150 kw. capacity. See "Official Notices" December 21st.

L.C.C.—January 22nd. 200 or 300 double-deck roof-covered car-bodies; 300 pairs of maximum traction swing bolster trucks; 300 electrical equipments for operation upon the overhead trolley and conduit system. See "Official Notices" December 28th.

Llandudno.—January 14th. Traction switchboard and surface condensing plant for the U.D.C. See "Official Notices" to-day.

Salford.—January 7th. The Tramways Committee invite tenders for an installation of electric light at the receiving offices, mess rooms, &c., Central Car Depôt, Frederick Road, Pendleton. Specification, &c., on application to the General Manager, Tramways Department, 32, Blackfriars Street, Salford, (one guinea deposit).

Wandsworth.—January 7th. Electric lamps for the B.C. See "Official Notices" December 21st.

West Ham.—January 10th. Coal for the electricity works. See "Official Notices" to-day.

CLOSED.

Barnstaple.—The T.C. has accepted the tender of the A.B.P. Co. for the supply of 200 sets of new plates for the battery, at 20s. per set.

Bristol.—The T.C. has entered into the following contracts for extensions of the generating plant:—

Siemens Bros.' Dynamo Works, Ltd.—Extra high-tension, high-tension and low-tension switchgear, Avonbank, third instalment, Docks sub-station and Temple Back.—£2,670.

British Westinghouse Electric & Manufacturing Co., Ltd.—3,000-kw. three-phase steam turbo-alternator, No. 10, Avonbank, third instalment.—£11,523.

Bruce Peebles & Co., Ltd.—Three-phase to direct-current converters for Avonbank, third instalment, Docks sub-station and Temple Back.—£3,074.

Derby.—The T.C. has accepted the tender of Messrs. E. Morley & Sons, Derby, for the extension of the E.L. works, at £14,800, and that of Mr. H. J. Coles, Derby, for the supply of a travelling crane for the electricity works, at £495.

Leyton.—The U.D.C. has placed an order with the present contractors for cars, viz., Messrs. Mountain & Gibson, Ltd., Messrs. Milnes, Voss & Co., Ltd., and the British Westinghouse Co., Ltd., to supply 20 extra cars of the same type as those in hand,

with top decks. In reply to an inquiry as to whether they would be prepared to deliver these 20 cars by March 31st next upon the existing contract terms, the British Westinghouse Co. wrote in the affirmative, provided the order was placed with them by January 2nd. Messrs. Milnes, Voss & Co. stated that they could not supply the car-bodies on the same terms, owing to the rise in the price of materials, &c., but would deliver the 20 bodies required for the sum of £340 each, the present contract price being £306. They further stated that delivery could not be made by the time mentioned, but they would be prepared to commence delivery towards the end of April, and complete delivery by May 31st. Messrs. Mountain and Gibson, Ltd., stated that they would be unable for the same reason, viz., increase in the price of materials, &c., to supply the car trucks upon the same terms, but would deliver the 20 trucks by March 31st, for the sum of £108 7s. each, to include wrought-iron wheels, which represent £5 10s. of the increase, the present contract price being £93 10s. each. The Council agreed to the above-mentioned terms, but instructed the electrical engineer to request Messrs. Milnes, Voss & Co. to make an earlier delivery of some of the car-bodies.

The U.D.C. has received the following tenders for cable:—

Lahmeyer Electrical Co., Ltd.	(accepted)	£1,244 0
Western Electric Co., Ltd.		1,537 10
Callender's Cable & Construction Co., Ltd.		1,543 10
Johnson & Phillips, Ltd...		1,572 0
W. T. Henley's Telegraph Works Co. ..		1,579 0
W. T. Glover & Co.		1,608 0
St. Helen's Cable & Rubber Co., Ltd. ..		1,645 0

Glasgow.—The Tramways Committee has accepted the following offers:—

Rotary converter and switchgear for Whitevale sub-station.—British Westinghouse Electrical & Manufacturing Co., Ltd.
Locks and key shields for telephone pillars.—Wm. Landell.
Cypress boards.—J. Potter & Co., Ltd.
Scrap copper.—British Insulated & Helsby Cables, Ltd.
Scrap lead.—Wm. Stevenson & Co.
Conversion of two equipments to regenerative control.—Raworth's Traction Patents, Ltd.
Fire-proof doors for Coplawhill Works.—Duncan Stewart.
Taps and dies, &c.—William Landell.
Lighting switches and cut-outs.—Edison & Swan United Electric Light Co.
Larch boards.—J. Cameron & Co.
Single-core lead-covered cable.—W. T. Glover & Co., Ltd.

Southampton.—The D.P. Battery Co., Ltd., Bakewell, have secured the contract for 245 cells capable of giving 500 amperes for one hour, for Southampton Docks.

Stoke-on-Trent.—The T.C. has accepted the tender of Callender's Cable & Construction Co., Ltd., for feeder cable, at £282.

FORTHCOMING EVENTS.

Saturday, January 5th.—At 3 p.m. Royal Institution. Mr. W. Duddell on "Signalling to a Distance, from Primitive Man to Radio-telegraphy."
Institution of Electrical Engineers (Manchester Students). Visit to the works of the Belsize Motor Car Co., Clayton.
Tuesday, January 8th.—At 3 p.m. Royal Institution. Mr. W. Duddell on "Signalling to a Distance, from Primitive Man to Radio-telegraphy." (Lecture 6, Radio-telegraphy.)
At 7.30 p.m. Institution of Electrical Engineers (Manchester). Mr. W. Cramp on "Magnetic Leakage and its Effect upon Electrical Design."
At 8 p.m. Institution of Electrical Engineers (Glasgow). A radium experiment will be exhibited by Dr. J. T. Bottomley. Adjourned discussion on Mr. H. B. Maxwell's paper on "Fuel Economy."
At 8 p.m. Institution of Civil Engineers. Mr. Francis Fox on "The Simplon Tunnel."
Wednesday, January 9th.—At 8 p.m. Association of Engineers-in-Charge. Mr. W. W. Melville on "Economisers."
Thursday, January 10th.—At 8 p.m. Institution of Electrical Engineers (London). Mr. James Swinburne on "New Incandescent Lamps."
Friday, January 11th.—At 7.30 p.m. Institution of Electrical Engineers (Manchester Students). Mr. F. Shaw on "Electric Lamps."
Saturday, January 12th.—Association of Engineers-in-Charge. Social Dance.

NOTES.

Correction.—In our report of the discussion on Mr. Miles Walker's paper (Vol. 59, p. 982), we unfortunately said that Mr. J. H. Bowden (Poplar) chose rotary converters in preference to motor-converters. As the context of his remarks plainly shows, the converse was the case.

A Railway-Ferry Combination.—It is reported from Stockholm that lively interest is being manifested in a scheme which has been submitted to the Swedish Government for the purpose of establishing a rapid and luxurious connection between Berlin and St. Petersburg *vid* Stockholm. The scheme provides for the construction of an electric railway between Stockholm and Trelleborg, or another suitable port in the south of Sweden, the connection of this port with Sassnitz on the Island of Rugen by means of an enormous steam ferry, and the building of an electric railway between Sassnitz and Berlin. It is also proposed under the scheme to install a steam ferry between Stockholm and Abo, in Finland, and to construct an electric railway between Abo and St. Petersburg. The completion of these plans would render it possible to accomplish the journey between Berlin and St. Petersburg in 20 hours, as compared with the 31 hours now required to cover the distance *vid* Eydtkuhnen.

The Boiler Explosion at the South Metropolitan Electric Light and Power Co.'s Works.—With reference to the boiler explosion which occurred at this company's generating station at Blackwall Point, Greenwich, on December 20th last, and was attended by the loss of two lives and injury to several others, the accident is definitely attributed to the giving way of the back-end plate of a thermal storage drum recently fitted over a Babcock & Wilcox boiler. Apart from a slight leakage, observed in the dished end of this drum on the previous evening, no warning of any kind was given.

The boiler is one of a battery of six, the thermal storage drum, 17 ft. long and 5 ft. diameter, was forced through the roof, falling some 100 yards away and rebounding into the premises of the gas company adjoining. Both the boiler house and engine room suffered considerable damage, and the East London Fire Brigade were quickly on the scene with a view to preventing a conflagration, although no water was actually used for this purpose. Although the supply from the station was immediately interrupted, the switchboard was unharmed and the other plant does not appear to have been seriously damaged.

Since the accident every effort has been made to render the supply available throughout the area at the earliest possible moment. A temporary roof has been erected over four of the engines, three of which have been run on artficial load, three of the boilers having been passed by the insurance company. The supply from this station will be resumed this week, and it will be run in conjunction with the Sydenham works of the same company until the new power station (adjoining the works where the explosion occurred, and nearly complete) is ready for working.

It should be noted that, the same evening as the accident occurred, the Sydenham works dealt with a very large portion of the lighting load, and has since been supplying lighting in the evening and power in the daytime. The company is insured with the National Boiler and General Insurance Co., Ltd., for the boilers and steam plant; with the Sun Fire Office for damage caused by fire; and with the London and Lancashire Co. against loss of life and injury.

On December 24th an inquest was opened by Mr. H. R. Oswald at the Greenwich Coroner's Court on the bodies of the two men killed, viz., W. W. Shaw, inspector for the National Boiler and General Insurance Co., and J. P. Coombes, a boilerman. Mr. George White, solicitor, appeared for the company, and Mr. J. A. Constable, the company's manager, gave evidence, from which it appeared that the explosion occurred at 4.5 p.m., he being in the vicinity at the time. The thermal storage drum in question on No. 6 boiler had been installed in August last, and was constructed for a working pressure of 160 lb. per sq. in., and tested to 230 lb. per sq. in. No official inspection had been made since August, although the works staff had inspected it in the usual way. Shaw was inspecting the drum, owing to the detection of slight leakage; the fires were not drawn on that account. Witness had formed the opinion that the material used in the construction of the drum was too brittle. A stoker having given evidence as to finding the bodies, the inquiry was adjourned for a fortnight.

Electric Traction on the Swiss Railways.—A lengthy report has been prepared by Dr. Wyssling, secretary of the Commission appointed in 1904 by the Swiss Government to investigate the question of substituting electric for steam traction on the National Railways, and has been published in *La Revue Electrique*. Dr. Wyssling finds that the energy required for one day in summer would amount to 1,200,000 H.P.-hours at the car axles, corresponding with 3,000,000 H.P.-hours on the shafts of the turbines; in winter 927,065 H.P.-hours would be needed, the mean being about one million. This would call for generating plant of 100,000 H.P., but as the maximum load in places very greatly exceeds the mean load, the ratio on the whole being not less than 5 : 1, at least 500,000 H.P. will have to be provided. To utilise the plant as economically as possible, storage reservoirs will be indispensable; these can only be constructed in places where the local conditions are favourable, so that it will be advisable to secure such falls as are suitable in this respect in good time. Obviously, it would be out of the question to make use of falls of such magnitude as to be able to deal with the maximum load without storage, as in that case the water would run to waste at times of light load. For economy in the installation of the necessary reserve plant, high falls must be chosen, and if the storage reservoirs cannot be placed near the power houses, indirect storage may have to be adopted. The efficiency of transmission from the turbines to the rails is estimated at 45 per cent. A certain amount of energy may be recovered by regeneration on inclines, but no great importance is attached to this, as it does not materially affect the maximum demand; its value is estimated at over 40 per cent. of the total energy used solely for traction, and is made up of 25 per cent. from kinetic energy, 16 per cent. from gravitation. The question whether, all things considered, electric traction will be cheaper than steam is not discussed; presumably, says our contemporary, because it will be reported on by another Commission. It is to be hoped that the latter will not lose sight of the benefit to be derived by both natives and visitors, from the abolition of the voluminous clouds of filthy smoke which at present defile the beautiful surroundings of the Swiss Railways.

Mass Movement of Electrical Officials in Berlin.—It is announced that the technical and commercial employés of the Allgemeine Co., in Berlin and vicinity, recently addressed a petition to the general management pointing out the increased cost of living, and asking for an increase in salaries. The petition contained 2,475 signatures, or about 96 per cent. of all the employés in these two classes. In the course of a reply, the general manage-

ment have now acknowledged the receipt of an "anonymous" petition, a term which is apparently explained by reason of the names of the signatories having been typewritten. The reply states that the management are accustomed to fix salaries not generally, but according to the diligence and capacity of each individual, and that regard has been had to the augmentation in the cost of living by annual improvements of the salaries, and by the granting of bonuses even in less favourable years. In this year also very considerable sums have been granted for increases in salaries, and, moreover, bonuses for employés have been proposed at the general meeting to an unusual extent. The management add that they do not wish to work with a dissatisfied *personnel* on the staff, and are, therefore, ready to accept notices until the end of the year. The Berlin newspapers state that the petition does not refer to the usual yearly increases, but to an extraordinary improvement in salaries consequent upon, and corresponding with, the dearness of the necessaries of life.

Electric Motor Vehicles in America.—With the view of fostering the development of electric motor vehicles, an Association of Electric Vehicle Manufacturers has recently been formed in New York. At the first meeting lately held a number of interesting papers were read, including one by Mr. H. Eames, on "The Electrical Vehicle: its Past, Present and Future;" one by Mr. J. MacNaughton, on "Electric Current as Utilised by Electric Vehicles, and the Central Station as a Source of Supply;" and one by Mr. H. Ford, on "Storage Batteries for Electric Vehicles."

Electro-Harmonic Society.—The next smoking concert is arranged to be held on Friday, the 11th inst., at the Holborn Restaurant. Mr. Geo. Flett will occupy the chair. The programme is a very full one. Vocal music will be rendered by the Æolian Quartette, Mr. Wm. Forinton, Mr. Herbert Emlyn, and Mr. H. J. Dunn. Mr. G. T. Miles will play two harp solos, and Mr. Alfred E. Izard has consented to render two solos on the pianoforte. Mr. Alexander Watson, Mr. Chas. Wreford, Mr. Will Edwards and Mr. Tom Clare will be responsible for the miscellaneous items.

E.E.R.E.(V.). — The Clyde Division of Electrical Engineers went into annual training at Fort Matilda, Greenock, under the command of Colonel D. F. D. Neill, in December, for the New Year holidays. The date of training has been changed from the summer in order to facilitate the working of searchlights, &c. Four officers and 70 men attended.

Coming Appointment.—The Legislative Assembly of New South Wales has passed the following motion:—"That in the opinion of this House the time has now arrived, considering the amount of electrical work undertaken by the Government, that the Works Department should obtain the services of an up-to-date electrical expert to control all the electrical works undertaken by the Department." It is anticipated that the selection of the engineer to be appointed will be made in London.

Educational Notes.—As a result of the recent Scholarship Examination held at Faraday House, a Maxwell Scholarship of 50 guineas a year, tenable for two years, has been awarded to George Henry Noel Reay, of Lancing College.

The Seddon Memorial Committee disapproves of the Inspector-General's scheme of technical scholarships, and proposes New Zealand fellowships and travelling fellowships, involving an expenditure of £12,000 per year.

King's College, London.—The Lent term commences on Tuesday next.

Institution and Lecture Notes.—Tramways and Light Railways Association.—The Official Circular for December of this Association contains a notice of the annual general meeting and of the changes that have been approved in the constitution, viz.:—The raising of the subscriptions of those not engaged in the working of tramways and light railways to two guineas per annum; the appointment of president and vice-presidents, the former holders of these offices (the Hon. Arthur Stanley, M.P., and Mr. J. B. Hamilton, of Leeds) remaining as chairman and vice-chairman at the head of the Council. The Duke of Argyll has accepted the presidentship.

Appointments Vacant.—Electrical engineer for Salford (£800, rising to £1,000); an assistant station superintendent is required at Ilford, at £3 per week. See "Official Notices" to-day.

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the Electrical Review *posted as to their movements.*

Central Station Engineers.—The inside staff at Darlington Electricity Works have presented Mr. F. W. Hewitt, the retiring assistant electrical engineer, with an American roll-top desk.

The Electricity and Light Railways Committee of Darlington T.C. has appointed Mr. G. F. Gregory, of Cambuslang, as junior engineer-in-charge at the electricity works.

Mr. J. A. T. Barnes, A.M.I.E.E., has been appointed engineer and manager of the Kendal Corporation Electricity Department.

Mr. Douglas A. C. Bailey has resigned his position as electrical engineer to the Central Collieries, Natal, having accepted an appointment under the corporation of King Williams Town.

Tramway Officials.—The Employés of the Coventry Electric Tramways Co. have presented a gold watch to the manager, Mr. T. R. Whitehead, as a token of esteem.

Mr. C. Tickel, of Oldham, has been appointed foreman of the overhead line equipment of the Leyton tramways at a salary of 45s. per week.

General.—On the last day of the old year Mr. John Ardron, C.B., retired from the office of senior assistant secretary to the Post Office, after nearly 43 years' service at St. Martin's-le-Grand. According to the *Times*, Mr. Ardron was born in 1843, and began his career at the General Post Office in 1864. "He has been identified with the progress and organisation of the telegraph service of the country ever since it was taken over from the private electric telegraph companies in February, 1870. Latterly Mr. Ardron has been assistant secretary for telephones and foreign and wireless telegraphs. In 1903, when the International Telegraph Conference met in London, Mr. Ardron occupied the chair. The C.B. was conferred upon him this year, and he has also received from the King of Denmark the Commandership of the Order of the Dannebrog."

Mr. A. M. Ogilvie has been appointed to be an Assistant Secretary in place of Mr. J. Ardron, C.B.

Mr. Robert Hornby, well known to central station engineers as sales manager of the Electrical Co.'s Meter Department, has resigned this position and joined Siemens' Dynamo Works, Ltd., of York Mansion, Westminster.

Dr. D. K. Morris, who has been Lecturer in Electrical Engineering in the University of Birmingham since 1898, resigned this position at Christmas. With his former colleague, Mr. G. A. Lister, he has established in Coventry a business for the manufacture of electrical specialities, switchgear and testing appliances. The address of this firm is Messrs. Morris & Lister, Carlton Works, Lockhurst Lane, Coventry.

Obituary.—Mr. Frank Jessop, chief inspector of the Lincoln Corporation Tramways, died on Christmas Day.

The *Times* announces the death of Mr. H. Doughty Browne, chairman of the Anglo-Argentine Tramways Co., Ltd., and ex-chairman of the London, Tilbury and Southend Railway.

NEW COMPANIES REGISTERED.

Kalgoorlie Electric Power and Lighting Corporation (1906), Ltd. (91,219).—This company was registered on December 14th, with a capital of £225,000 in 175,000 6 per cent. non-cumulative preference shares of £1 each and 100,000 ordinary shares of 10s. each, to acquire the undertaking and all or any of the assets and liabilities of the Kalgoorlie Electric Power and Lighting Corporation, Ltd. (incorporated in 1899), and to carry on the business of generators and suppliers of electricity for mining and other purposes, electrical engineers and contractors, manufacturers of and dealers in railway, tramway, electric and other appliances, &c. The first subscribers (each with one ordinary share) are:—G. E. Sanders, 51, Larkfield Road, Richmond, Surrey, clerk; A. J. Swan, 18, Ashbourne Grove, Chiswick Lane, Chiswick, clerk; S. H. Penwarden, 7, Comely Bank Road, Walthamstow, clerk; H. W. Brown, 63, Mackenzie Road, Beckenham, clerk; P. M. Cullen, 30, Paxton Road, St. Albans, Herts, clerk; E. T. Church, 2, Kepler Road, Clapham, S.W., clerk; and H. Spinks, 135, Clifden Road, Clapton Park, N.E., clerk. No initial public issue. The number of directors is not to be less than three or more than seven; the subscribers are to appoint the first; qualification, £250; remuneration, £250 each per annum (£100 extra for the chairman) and 10 per cent. of the surplus net profits remaining after 8 per cent. is paid on the ordinary shares, divisible.

Mors (England), Ltd. (91,221).—This company was registered on December 14th, with a capital of £1,000 in £1 shares, to acquire the sole agency in the United Kingdom and its Colonies and dependencies for motor chassis and cars made by the Société Anonyme d'Electricite et d'Automobiles Mors, Paris, and to adopt an agreement between the said Société, the Roadway Autocar Co., Ltd., and Charles Jarrott and Letts, Ltd. The first subscribers are:—C. Jarrott, 45, Great Marlborough Street, W., gentleman, 2 shares; H. J. Hubbard, 44, Lotham Road, Finsbury Park, N., cashier; L. Carle, 55, Shaftesbury Avenue, W., engineer; H. Portlock, 1, Abbotstone Road, Putney, S.W., accountant; H. G. Ireland, 22, Jackson Road, Holloway, N., cashier; F. Eason, 34, Wilton Road, Muswell Hill, N., gentleman; and H. B. Reid, 70, Victoria Street, S.W., gentleman (the last six taking one share each). No initial public issue. The number of directors is not to be more than seven; C. Jarrott is the first director; remuneration as fixed by the company. Registered office, 45, Great Marlborough Street, W.

Tubes, Ltd. (91,224).—This company was registered on December 14th, with a capital of £100,000 in £1 shares, to acquire the business carried on at Birmingham by a company of the same name (now in liquidation), and to carry on in the United Kingdom or elsewhere the business of manufacturers of and dealers in metal tubes of every description, &c. The first subscribers (each with one share) are:—Arthur Chamberlain, J.P., Moor Green Hall, Birmingham; P. Hookham, 6, Pakenham Road, Edgbaston, manufacturer; J. S. Nettlefold, J.P., Edgbaston Park Road, Birmingham; Arthur Chamberlain, jun., Moor Green Hall, Birmingham, manufacturer; J. H. Aston, St. Anne's, Erdington, director; J. Melvin, St. Bernard's Grange, Olton, game salesman; and C. Richards, 78, Butt Street, Birmingham, draper. No initial public issue. 20,000 of the original shares are to be issued as ordinary shares in pursuance of the reconstruction agreement. The directors may from time to time issue shares (not exceeding in amount the nominal amount of the issued ordinary capital), as preference shares, carrying a cumulative preferential dividend of not more than 5 per cent. and other limited rights of participating in profits. The number of directors is not to be less than two or more than seven; the first are Arthur Chamberlain and J. H. Aston; qualification, 500 ordinary shares; remuneration according to profits.

Berry Construction Co., Ltd. (91,165).—This company was registered on December 11th, with a capital of £10,000 in £1 shares, to turn to account the inventions of A. F. Berry in connection with electrical heating and cooking, and to carry on the business of electricians, engineers, suppliers of electricity for motive power, light and heat, manufacturers of electrical apparatus, &c. The first subscribers are:—R. K. Berry, Ashley, Market Harborough, farmer, 1,000 shares; R. E. Berry, 5, Sylvan Place, Edinburgh, brewer, 750 shares; G. Berry, Colne Mead, West Drayton, engineer, 750 shares; A. F. Berry, 27, Woodville Road, Ealing, engineer, 1,000 shares; F. E. Berry, Napoleon Villa, West Drayton, engineer, 1 share; L. Roffey, 37, Sparsholt Road Crouch Hill, N., clerk, 1 share; and C. Anderson, 36, Goodge Street, W., clerk, 1 share. No initial public issue; the number of directors is not to be less than two or more than five; the first are A. F. Berry (managing director) and R. E. Berry; qualification, 500 shares; remuneration, £50 each per annum (chairman £100) and 10 per cent. of the net profits remaining after 10 per cent. dividend is paid, divisible. Registered office, Hastings House, 10, Norfolk Street, Strand, W.C.

Geneva Tramways Co. (1906), Ltd. (91,264).—This company was registered on December 17th, with a capital of £550,000 in £1 shares, to carry on in Geneva or elsewhere, the business of tramway and light railway constructors and owners, and in particular to take over all or any of the assets of the Geneva Tramways Co., Ltd., including especially all or any of the shares in La Compagnie Genevoise des Tramways Electriques and all or any of the founders' certificates issued by that company, and to adopt an agreement with the Geneva Tramways Co., Ltd. The first subscribers (each with one share) are:—J. R. Dutton, 41, Dalrymple Road, Brockley, S.E., clerk; C. Thomas, Heathfield, Glamorgan Road, Hampton Wick, clerk; F. Clarke, 8, Montagu Road, Wimbledon, S.W., clerk; G. H. Kennedy, 8, Fernside Road, Balham, clerk; E. J. Shaw, 65, Norfolk House Road, Streatham, S.W., clerk; C. H. Dean, 12, St. James's Place, S.W., clerk; and E. J. Burridge, 106, Fentiman Road, Clapham, S.W., clerk. No initial public issue. The number of directors is not to be less than three or more than seven; the first are R. T. Bayliss, O. Beit, The Hon. Arthur G. Brand and J. Secar; qualification, 100 shares; remuneration (except managing director, if any) £125 each per annum, with £125 extra for the chairman. The directors are (pursuant to the said agreement) to create £300,000 4 per cent. debentures, and may borrow up to a further £100,000 without the sanction of a general meeting. Registered office, 241, Salisbury House, London Wall, E.C.

Quebec and Lake Huron Construction Co., Ltd. (91,291).—This company was registered on December 18th, with a capital of £100,000 in 99,500 ordinary shares of £1 each and 10,000 deferred shares of 1s. each, to adopt an agreement with Messrs. Steele, Lockhart & Co., to construct, equip, work and maintain railways, light railways and tramways in Canada and elsewhere, and in particular the railway from Lake Huron to Quebec, authorised by the Dominion Parliament, to manufacture rolling stock, to own and work telegraph and telephone lines, docks, wharves and quays, to carry on the business of electricians, engineers, contractors, manufacturers of accumulators, dynamos, motors and machinery, &c. The first subscribers (each with one share) are:—H. P. Cousins, 62, London Wall, E.C., secretary; G. Thomas, 62, London Wall, E.C., clerk; H. Lea, 475, Holloway Road, N., clerk; J. O. Kettridge, 62, London Wall, E.C., accountant; G. N. Wills, 62, London Wall, E.C., secretary; A. H. Dwight, 25, Fanthorpe Street, Putney, S.W., secretary; and H. W. Vant, 62, London Wall, E.C., clerk. No initial public issue. The number of directors is not to be less than three or more than seven; the subscribers are to appoint the first; qualification, £250; remuneration, 2 per cent. of the net profits, divisible.

John M. Kaiser, Ltd. (91,338).—This company was registered on December 20th, with a capital of £1,000 in £1 shares, to acquire the business carried on at Dale End and Coleshill Street, Birmingham, as "John M. Kaiser," and to carry on the business of electrical and mechanical engineers and contractors, manufacturers of electrical and other instruments and accessories, electricians, suppliers of electricity, &c. The first subscribers (each with one share) are:—T. Timmons, Trefonnen, Woodfield Road, King's Heath, gentleman; J. M. Kaiser, 43, Hagley Road, Birmingham, electrical engineer; F. E. Collins, 6, Hunters Road, Handsworth, electrical engineer; W. L. Powell, 35, Carr's Lane, Birmingham, gunmaker; C. K. Crosley, 14, Exeter Place, Birmingham, electrical engineer; Mrs. M. Kaiser, 43, Hagley Road, Birmingham; and S. F. Wright, 39, Corporation Street, Birmingham, accountant. No initial public issue; the number of directors is not to be less than three or more than five; the first are J. M. Kaiser (managing director for five years, with £208 per annum and 10 per cent. of the net profits after 10 per cent. has been paid on the ordinary shares) and F. E. Collins.

Warriner, Ltd. (91,298).—This company was registered on December 18th, with a capital of £1,000 in £1 shares, to carry on the business of motor-car, motor-omnibus, cycle and flying machine manufacturers, ironmongers, electrical and general engineers, electricians, manufacturers of electric light cables, dynamos, motors, telephones, bells, electroliers, arc and other lamps, electric light fittings, heating and cooking apparatus and telegraph wires and accessories, dealers in india-rubber, asbestos and insulating materials, &c. The first subscribers (each with one share) are:—H. S. Warriner, York Cottage, Doncaster, coachbuilder; G. E. Wroe, 145, Bentley Road, Doncaster, clerk; Mabel E. Richmond, 32, Park Crescent, Peel Park, Bradford, clerk; C. Wragg, 21, Great Central Avenue, Doncaster, clerk; W. J. Axworthy, Riverside Works, Doncaster, engineer; Mrs. A. Sampson, 80, Bentley Road, Doncaster; and Mary M. Whiteley, Crimpsall Cottage, Doncaster. No initial public issue. The number of directors is not to be less than two or more than seven; the subscribers are to appoint the first; qualification, 50 shares; remuneration, 10 per cent. of the net profits, divisible. Secretary and registered office, H. Sampson, Riverside Works, Doncaster.

Vulcan Motor and Engineering Co. (1906), Ltd. (91,297).—This company was registered on December 18th, with a capital of £75,000 in £1 shares (20,000 6 per cent. cumulative preference), to acquire the business of the Vulcan Motor Manufacturing and Engineering Co., Ltd. (incorporated in 1903), and to carry on the business of manufacturers of steam, petrol, electric and other motors for cars, carts, vans, cycles, launches and yachts, mechanical and electrical engineers, founders, tube makers, smiths, electro-platers, japanners, &c. The first subscribers are:—T. Hampson, 34, Derby Road, Southport, engineer, 500 preference shares; D. Purves, 3, Park Crescent, Southport, 500 preference shares; E. Hope, Fairfield, Heaton, Bolton, cotton spinner, 1 preference share; R. O. Taylor, 40, Grosvenor Road, Birkdale, cotton spinner, 1 preference share; F. S. Marsh, 43, Hartwood Road, Southport, chartered accountant, 1 preference share; J. Hampson, 35, Hawside Street, Southport, engineer, 1 preference share; and W. E. Walker, 61, Clifton Road, Southport, cashier, 1 preference share. No initial public issue. The number of directors is not to be less than three or more than seven; the first are H. E. Lees, 26, Corporation Street, Manchester; D. Purves, and T. Hampson, with power to add to their number before the annual meeting in 1909; qualification, £500; remuneration, £400 per annum, divisible. Registered office, Hawside Street, Southport.

British Westfalite, Ltd. (91,389).—This company was registered on December 22nd, with a capital of £10,007 in £1 shares, to adopt an agreement with H. Kent and to carry on the business of manufacturers and factors of and dealers in Westfalite and other explosive substances, makers of electric and other detonators, suppliers of such explosives and detonators to railway, mining, blasting and other contractors, ammunition manufacturers, &c. The first subscribers (each with one share) are:—T. Maskall, Lulworth House, Surbiton Hall, Surrey, chartered accountant; H. A. H. Cole, 12, Richmond Bridge Mansions, Twickenham, chartered accountant; R. E. Gisburne, The Shanty, Pinner, chartered accountant; F. Sparey, 34, Church Road, Stoke Newington, N., clerk; H. Dobell, 47, Maberley Road, Upper Norwood, S.E., chartered accountant; W. Northcott, 35, Vaughan Terrace, Harrow-on-the-Hill, Middlesex, clerk; and J. F. Stokes, 358, Strone Road, Manor Park, E., clerk. No initial public issue. The number of directors is not to be less than three or more than seven; the subscribers are to appoint the first.

New Ignition Syndicate, Ltd. (91,175).—This company was registered on December 11th, with a capital of £6,000 in £1 shares, with objects as indicated by the title. The first subscribers (each with one share) are:—W. J. L. Sandy, 90, Breyard Road, S.E., electrical engineer; H. T. Middleton, 65A, Cannon Street, E.C., mining engineer; C. Woodhouse, 6, John Street, Adelphi, W.C., clerk; R. W. C. Fenton, 85, Comeragh Road, West Kensington, officer (retired); A. W. Fenton, M.A., M.D., 107, Park Lane, Croydon; A. H. Atchley, Moorgate Station Chambers, E.C., merchant; and L. Carter, 1, Argyll Street, W., solicitor. No initial public issue. The first directors are A. W. Fenton, W. J. L. Sandy (managing director), and H. T. Middleton. Registered office, 6, John Street, Adelphi, W.C.

J. W. Greenwood, Ltd. (91,231).—This company was registered on December 14th, with a capital of £5,000 in £1 shares (2,500 preference), to adopt an agreement with J. W. Greenwood, and to carry on the business of proprietors or hirers of motor-cars and other vehicles, carriers of passengers and goods, electricians, engineers, garage keepers, producers and suppliers of electricity, &c. The first subscribers (each with one share) are:—J. W. Greenwood, 51, Cheltenham Place, Halifax, electrical engineer; E. E. Hyatt, Mill House, Birkenshaw, gentleman; W. H. Jackson, 5, Fountain Street, Halifax, solicitor; A. P. L. Maude, 19, Skircoat Moor Road, Halifax, articled clerk; A. H. Firth, 16, Bedford Terrace, Hopwood Lane, Halifax, clerk; F. Cockroft, 32, Mount Tabot, Halifax, clerk; and F. Lewin, 6, Market Street, Halifax, patent agent. No initial public issue. Table "A" mainly applies.

Aluminium Castings Co., Ltd. (6,373).—This company was registered in Edinburgh on December 26th, with a capital of £20,000 in £1 shares, to acquire all the heritable and movable properties in Greenock and elsewhere belonging to the Aluminium Castings Co., and to carry on in the United Kingdom and elsewhere, the business of manufacturers of and dealers in castings of aluminium or any other metal, mechanical, electrical and general engineers, metal-workers, &c. The first subscribers (each with one share) are:—A. Caird, Greenock, shipbuilder; A. Lindsay, Greenock, merchant; A. Carmichael, Greenock, shipowner; H. J. Bubb, Greenock, manufacturer; J. H. Cox, Greenock, manufacturer; T. B. Rowan, Greenock, solicitor; and D. McLaren, 11, Ingleston Street, Greenock, secretary. The number of directors is not to be less than three or more than seven; the first are A. Caird, A. Lindsay, A. Carmichael, H. J. Bubb and J. H. Cox; qualification, £100; remuneration, £10 each per annum. Registered office, 11, Ingleston Street, Greenock.

Empire Light, Ltd. (91,364).—This company was registered on December 21st, with a capital of £10,000 in £1 shares, to carry on the business of a lighting and heating company, and that of lamp and stove manufacturers, electrical and mechanical engineers, &c. The first subscribers (each with one share) are:—P. E. Morris, The Mascot, Monkham's Avenue, Woodford Green, gentlemen; F. P. J. Daniels, 11, Kenilworth Court, Putney, gentlemen; J. H. Miess, Radcliffe House, Radcliffe Lane, Harlesden, N.W., gentleman; E. J. Morris, Homestead, Woodford Green, gentlemen; D. Pickens, 2, Ashchurch Park Villas, Shepherd's Bush, clerk; T. W. Doran, 114, Hawksley Road, Stoke Newington, N., clerk; and H. Jacques, 45, Lancaster Road, W., clerk. No initial public issue. The number of directors is not to be less than three or more than seven; the subscribers are to appoint the first; qualification £50; remuneration (except managing director) £25 each per annum.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Edison and Swan United Electric Light Co., Ltd. (18,984).—This company's annual return was filed on November 5th, when 116,400 "A" and 23,564 "B" shares had been taken up out of a nominal capital of £:88,071 in 150,000 "A" and 26,436 "B" shares of £5 each and 23,564 "B" shares of 5s. each; 10s. per share has been called up on 89,261 "A" shares, and £44,630 10s. has been received; £344,738 10s. is considered as paid, being £5 per share on 17,139 "A," 10s. per share on 23,564 "B," £2 10s. per share on 89,261 "A," and £3 per share on 10,000 "A." Mortgage and charges: £391,695.

Hall's Transmission Gear Syndicate, Ltd. (London) (83,191).—Issue on November 15th of 600 5 per cent. debentures, part of series created February 9th, 1905, to secure £20,000, charged on freehold lands in Ipswich, certain patents and rights and the company's undertaking and property, present and future, except unpaid capital. Trustees: F. Barker, Chatsworth Lodge, Grove Park, Chiswick; and H. Wade, 111, Hatton Garden, E.C. Previously issued of same series: £10,550.

Burgess Hill and District Electric Supply Co., Ltd. (85,698).—A deed of charge dated November 29th, 1906, to secure an unspecified amount, but stamped to cover £700, has been registered. Property charged: The company's interest in land at Burgess Hill, and all plant, trade fixtures, &c., thereon. Holders: Barclay & Co., Ltd.

Singapore Electric Tramways, Ltd. (84,088).—A trust deed dated November 30th, 1906, to secure £350,000 debentures, created June 1st, 1905, has been registered. Property charged (specifically): 2,000 fully paid £1 shares in the Singapore Tramways, Ltd., constituting the whole nominal capital of such company, with provision for substituting for such shares the undertaking of the Singapore Tramways when the same are completed and assigned to the company, with the concession under which the same are constructed. (As a floating security): The company's other assets, present and future, including uncalled capital. Trustees: J. E. Prestwich, Farnworth; and W. H. Fish, 14, Lulworth Road, Birkdale.

South African Lighting Association, Ltd. (27,609).—Issue on November 28th of £6,870 5 per cent. debentures, part of series created May 27th, 1903, to secure £10,000, charged on the company's undertaking and property, present and future, subject to a first charge for £20,000. No trustees. No previous issue of same series.

Hunter Electric Candle Lamp Co., Ltd. (81,387).—This company's annual return was filed on November 14th, when the entire capital of £800 in £1 shares had been taken up. £500 has been received, and £300 is considered as paid. Mortgages and charges: Nil.

Standard Construction Corporation, Ltd. (72,908).—This company's annual return was filed on December 5th, when 117,107 shares had been taken up out of a nominal capital of £150,000 in £1 shares. 4s. per share has been called up on 117,100 and £1 on 7, resulting in the receipt of £23,427. Mortgages and charges: Nil.

Monte Video Telephone Co., Ltd. (27,208).—This company's annual return was filed on November 5th, when 86,492 preference and 72,680 ordinary shares had been taken up out of a nominal capital of £160,000 in 87,000 preference and 73,000 ordinary shares of £1 each. £159,172 is considered as paid. Mortgages and charges: Nil.

Farnham and District Electric Supply Co., Ltd. (81,401).—This company's annual return, made up to July 14th, 1905, was filed on November 5th, 1906. 307 shares have been taken up out of a nominal capital of £1,000 in £1 shares. £300 has been received, leaving £7 in arrears. Mortgages and charges: Nil.

Engineering Instruments, Ltd., London (66,427).—A memorandum of satisfaction in full of debentures dated October 18th, 1905, securing £2,000, has been registered.

Drake & Gorham, Ltd. (70,275).—This company's annual return was filed on November 16th, when the entire capital of £125,000 in £1 shares had been taken up. £85,000 has been received, and £40,000 is considered as paid. Mortgages and charges: Nil.

Pacific and European Telegraph Co., Ltd. (36,683).—This company's annual return was filed on November 29th, when the entire capital of £100,000 in 10,000 shares of £10 each had been taken up. £4 per share has been called up, and £40,000 has been received. Mortgages and charges: £99,400.

British Thomson-Houston Co., Ltd. (47,982).—This company's annual return was filed on October 15th, when the entire capital of £800,000 in 40,000 ordinary and 40,000 preference shares of £10 each had been taken up. £10 per share has been called up on 32,531 ordinary and 40,000 preference, and £725,310 has been received. £74,690 is considered as paid on 7,469 ordinary. Mortgages and charges: £212,000.

Southport Tramways Co., Ltd. (5,592).—A debenture dated November 27th, 1906, to secure £2,500, charged on the company's undertaking and property, present and future, including uncalled capital, subject, as to depots or proceeds of sale thereof, to the lien of the Southport Corporation thereon, has been registered. Holder: J. Hesketh, Southport; and S. B. Murray, 5, Threadneedle Street, E.C.

C. and A. Musker (1901), Ltd. (Electrical and general engineers, Liverpool) (70,573).—A memorandum of satisfaction in full of debentures dated May 10th, 1905, securing £20,000, has been filed.

Sunbeam Lamp Co., Ltd. (Gateshead) (25,498).—Issue on November 29th of £300 4½ per cent. debentures, part of series created January 28th, 1904, to secure £10,000, charged on the company's undertaking and property, present and future, except uncalled and unpaid capital. No trustees. Previously issued of same series: £8,500.

London United Tramways (1901), Ltd. (71,844).—A debenture dated November 18th, 1906, to secure £300,000, has been registered. Property charged:—The company's undertaking and property, including uncalled and unpaid capital (except building land adjoining the company's Fulwell depôt and the Tray Town property at Brentford, and the lands, tenements and hereditaments now or hereafter acquired under the powers of the London United Tramways Acts, 1873 to 1906, or acquired for or in connection with street or road widening and improvements), subject to a trust deed dated February 26th, 1902, and the first mortgage debenture stock issued on the security thereof. Holders: Parr's Bank, Ltd., Bartholomew Lane, E.C.

United Electric Tramways Co. of Caracas, Ltd. (89,642). A trust deed dated November 19th, 1906, to secure £200,000 first mortgage debenture stock created by resolution of even date, has been registered. Property charged: 1,272 shares of Bolivaro 500 each in the capital of the Compania de Tranvias Electricos de Caracas, the benefit of an agreement with the last-named company, and the company's undertaking and property, present and future, including uncalled capital. Trustees: Consolidated Trust, Ltd., 4, Throgmorton Avenue, E.C.

Benton, Keighley & Reynolds, Ltd. (Electrical and general engineers, Fulham). (84,661).—Issue on November 16th of a £250 5 per cent. debenture, part of series created same date to secure £2,000, charged on the company's undertaking and property, present and future, including uncalled capital (ranking in priority to earlier debentures). No trustees. Issued on same date, but previously registered £500.

New St. Helens and District Tramways Co., Ltd. (59,426). —This company's annual return was filed on October 19th, when 15,980 preference and 9,000 ordinary shares had been taken up out of a nominal capital of £150,000 in 20,000 preference and 10,000 ordinary shares of £5 each; £5 per share has been called up, resulting in the receipt of £125,410, including £510 paid on 1,020 forfeited shares. Mortgages and charges: Nil.

CITY NOTES.

Blackpool, St. Anne's and Lytham Tramways Co.—Mr. T. Blane presided at the annual meeting held last week at Blackpool. He moved the adoption of the report, which showed an increase of profit, as compared with previous years, of £2,500. A sum of £1,500 was added to the sinking fund, and £979 was written off for conversion of cars from gas traction to electricity. At present, the chairman said, they were checked at Lytham, but arrangements were being made for a double line there.

The report was adopted.

The South Blackpool Electric Tramways Co. held its meeting afterwards. The CHAIRMAN said it was proposed to wind up this company 12 months hence.

Buenos Ayres Grand National Tramways Co., Ltd.—Mr. J. Irving Courtenay presided on Wednesday at the annual meeting. He referred mainly to the progress being made with the work of electrification. The report was adopted.

Stock Exchange Notices.—The Committee has ordered the undermentioned securities to be quoted in the Official List:—

Kalgoorlie Electric Tramways, Ltd.—250,000 shares of £1 each, fully paid, Nos. 1 to 250,000.

Perth Electric Tramways, Ltd.—100,000 ordinary shares of £1 each, fully paid, Nos. 1 to 100,000.

Application has been made to the Committee to allow the following securities to be quoted in the Official List:—

Lanarkshire Tramways Co.—28,723 shares of £10 each, fully paid.

Douglas Southern Electric Tramways Co., Ltd.—A dividend at the rate of 1¼ per cent for the year ended October 31st is recommended; £344 is carried forward.

Electric and General Investment Co., Ltd.—The directors have declared an interim dividend at the rate of 10 per cent. per annum on the ordinary shares, being 1s. per share for the six months ended 30th ult., less income-tax.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS.

Locality.	Fortnight ended.	Receipts for the fortnight. £	Receipts for the fortnight. £*	No. of wks.	Total to date. £	Total to date. £*	Route miles open.
Aberdeen	Dec. 26	2,354	— 100	29	44,339	+ 1,967	14·4
Ayr	,, 15	335	— 12	31	10,482	+ 148	6
Bath	,, 26	1,538	— 37	52	42,491	+ 6,859	13
Belfast	,, 29	7,276	— 270	51	173,015	+48,523	40 + 6½
Birkenhead	,, 30	2,027	— 26	34	41,642	+ 924	15·5
Blackburn	,, 26	2,048	+ 105	39½	41,308	+ 2,599	13·6
Blackpool Corp.	,, 27	639	— 58	37	48,918	+ 3,603	11·87
,, —Fleetw'd	,, 29	369	— 51	27	23,994	+ 3,763	8·25
†Bolton	,, 23	2,013	+ 138	38	81,470	+ 6,577	26 + 1
Bournemouth	,, 26	2,6·2	— 346	38½	66,004	+10,114	20·5 + 1½
†Bradford	,, 22	4,263	+ 47	38	174,088	+ 6,944	58 + ·7
Brighton	,, 30	1,494	— 288	39	39,540	..	9·5 ..
Bristol	,, 23	10,468	— 113	..	..	..	28·5 ..
Brit. Elec. Trac. Co.							
Airdrie	,, 21	417	— 12	51	11,329	+ 807	3·65 ..
Barnsley	,, 21	227	— 21	,,	8,932	+ 65	.. ..
Barrow	,, 21	414	..	,,	13,115	+ 949	5·37 ..
Cavehill	,, 21	88	+ 19	,,	4,394	+ 1,955	.. ..
Devonport	,, 21	869	+ 26	,,	23,380	+ 173	5 ..
Gateshead	,, 21	1,931	+ 36	,,	4,676	+ 2,633	11·25 ..
Gravesend	,, 21	406	+ 4	,,	12,314	+ 636	6·5 ..
Greenock	,, 21	1,102	— 127	,,	33,427	+ 685	7·25 ..
Hartlepool	,, 21	460	— 34	,,	15,157	+ 1,630	6·72 ..
Kidderminster	,, 21	178	— 4	,,	6,016	— 51	.. ..
Leamington	,, 21	244	— 16	,,	8,729	+ 2,703	3 ..
Merthyr	,, 21	370	+ 23	,,	10,095	+ 504	2·9 ..
‡Metropolitan	,, 21	5,148	+ 833	,,	174,131	+38,795	22 ..
Middleton	,, 21	525	— 38	,,	17,708	+ 661	8·5 ..
Mid. Joint Com'tee	,, 21	17,612	—2,554	,,	507,653	+ 8,907	.. ..
Oldham — Ashton	,, 21	1,053	— 9	,,	29,143	+ 776	9·13 ..
Peterborough	,, 21	194	— 4	,,	6,530	— 229	5·31 ..
Potteries	,, 21	3,705	+ 113	,,	92,000	+ 4,543	29 ..
Rothesay	,, 21	78	..	,,	10,969	+ 1,612	2·75 ..
Southport	,, 21	413	— 22	,,	16,100	+ 512	8·17 ..
S. Metropolitan	,, 21	1,165	..	45	17,002	..	.. ..
Swansea	,, 21	1,563	— 28	51	42,945	+ 6,065	5·5 ..
Tynemouth	,, 21	278	— 67	,,	12,794	— 88	3·75 ..
Weston-s-Mare	,, 19	49	— 3	,,	7,463	+ 635	3 ..
‡Worcester	,, 21	265	— 14	,,	14,384	— 797	5·75 ..
Wrexham	,, 21	186	— 1	,,	5,294	+ 189	.. ..
Yorks. Wool. Dist.	,, 21	1,623	+ 22	,,	46,101	+11,879	17 ..
Miscellaneous	,, 21	332	— 7	,,	5,627	— 263	.. ..
Burnley	,, 29	2,392	+ 57	51	..	..	7·5 ..
Burton-on-Trent	,, 30	571	— 25	39	11,775	— 433	10 + 1·5
†Bury	,, 23	864	..	38	37,623	..	10·5 ..
†Cardiff	,, 15	1,881	+ 78	37	77,966	+ 1,432	15·87 ..
Carlisle	,, 29	326	— 37	52	9,573	+ 110	.. ..
Chatham and Dist.	,, 27	1,281	— 35	52	35,728	+ 1,820	12·8 + 3·5
Cork	,, 27	898	— 57	52	24,818	— 98	9·89 ..
Croydon	,, 28	2,519	— 148	38	44,680	+ 4,038	12 + ¾
†Darlington	,, 15	184	+ 3	37	7,923	+ 298	4·87 ..
Darwen	,, 28	522	+ 16	39	10,043	+ 493	4·36 ..
Dover	,, 22	361	- 15	38	10,010	+ 1,203	4·75 ..
Dublin	,, 28	9,863	+ 386	26	136,835	+ 5,894	18·75 + ·25
Dundee	,, 26	2,058	+ 107	30	35,694	+ 6,085	13 + ·5
East Ham	,, 29	1,635	— 107	39	35,560	+ 3,066	8 + ½
Exeter	,, 28	568	+ 15	39	11,758	+ 415	4·75 + ·5
†Glasgow	,, 22	16,558	+ 721	32	497,534	+44,335	80·75 +11
Hastings	,, 28	1,201	..	..	..	..	.. ..
†Huddersfield	,, 29	1,359	+ 59	39	59,764	+ 5,388	28 ..
Hull	,, 29	5,008	+ 226	39	91,230	+ 3,866	13 ..
†Ilford	,, 8	408	+ 16	36	17,749	+ 431	6·37 ..
Ilkeston	,, 26	209	— 24	39	5,259	+ 595	3·5 ..
Ipswich	,, 29	615	— 165	39	17,103	— 13	10·5 ..
Isle of Thanet	,, 29	411	— 126	52	32,382	+ 808	11 ..
Kilmarnock	,, 29	293	— 12	33	5,260	+ 86	4·25 ..
†Kirkcaldy	,, 19	283	+ 33	..	..	..	7·5 ..
Lan'kshire Trm. Co.	,, 27	1,643	— 10	52	45,849	+ 6,586	12·56 + ½
Lancashire United	,, 26	2,047	+ 256	52	52,072	+ 7,392	37 + 9
†Leeds	,, 22	5,927	— 67	36	240,505	+15,488	96 + 6·5
Leicester	,, 29	4,403	— 124	52	..	..	.. ..
Leith	,, 22	901	+ 55	32	16,639	+ 5,798	6 + 1
†Liverpool	,, 15	10,467	+ 230	50	539,493	+13,686	104 + 1
‡L.C.C.	,, 15	50,891	+21,253	37	972,471	+425,172	113·1 +62½
London United	,, 28	10,635	+ 388	52	318,768	+27,542	.. ..
†Lowestoft	,, 29	110	— 85	13	2,201	+ 225	3·5 ..
†Manchester	,, 22	13,899	+ 460	38	529,796	+39,785	146 +21
†Newcastle	,, 22	4,133	+ 66	38	155,577	+11,704	25·5 ..
Newport	,, 29	1,253	— 14	39	24,997	+ 1,828	14·5 + 1·5
Northampton	,, 28	829	- 33	39	17,406	+ 525	5·5 ..
Oldham	,, 30	3,062	— 177	40	72,852	+ 6,628	20·75 ..
Pontypridd	,, 29	368	+ 13	39	6,583	+ 311	9·5 ..
†Portsmouth	,, 29	1,216	— 93	39	79,512	+ 352	14·7 ..
†Preston	,, 19	658	+ 107	..	..	..	10 ..
Reading	,, 27	1,267	— 10	39	25,097	+ 486	7·5 ..
Rochdale	,, 29	1,793	+ 33	38	..	..	20·6 ..
Rotherham	,, 27	1,098	+ 40	39	19,819	+ 1,862	10 + ·66
†Salford	,, 17	4,098	..	37	169,008	+ 6,438	38·9 ..
†Sheffield	,, 23	5,412	+ 122	39	207,692	+15,067	35·75 + 1½
Southampton	,, 26	1,732	— 75	38½	38,166	+ 494	.. ..
Southend-on-Sea	,, 12	490	+ 37	37	15,753	+ 1,036	6 ..
Sunderland	,, 29	2,670	— 16	39	55,403	+ 3,113	10·87 ..
Swindon	,, 19	293	— 38	38	6,743	— 587	4·4 ..
†Tyneside	,, 17	381	+ 41	51	23,012	+ 2,228	8·87 ..
†Walthamstow	,, 29	899	+ 66	39	23,181	..	9 ..
West Ham	,, 27	4,483	+ 101	39	88,752	+17,661	14·7 + 1·4
Wolverhampton	,, 19	831	+ 71	37	32,470	+ 1,770	12·5 ..
Yorks. W. Riding	,, 30	2,187	+ 448	52	45,317	..	.. ..
Baker St.-Waterloo	,, 29	4,495	..	26	43,710	..	3·75 ..
Cen. London Rly.	,, 29	11,889	—1,290	26	157,715	— 8,253	6 ..
City & S. Lon. Rly.	,, 30	6,392	+ 499	26	71,304	+ 1,941	6·25 ..
†Dublin-Lucan Rly.	,, 21	97	— 11	25	3,080	— 11	7 ..
G.N. and City Rly.	,, 29	3,798	+ 110	26	45,126	+ 2,634	3·5 ..
G.N., P'dy. & Bromp.	,, 29	6,335	..	2	6,335	..	9 ..
L'pool Overh'd Rly.	,, 30	2,574	— 153	26	37,975	— 573	6·8 ..
Mersey Railway	,, 29	4,012	+ 217	26	44,996	+ 3,162	4·5 ..
Metropolitan Rly.	,, 30	32,239	..	26	391,804	..	70·5 ..
Met. District Rly.	,, 30	15,472	— 342	26	201,090	+13,075	24 ..
†Anglo-Argentine	,, 23	17,379	+1,723	51	783,273	+92,321	43 ..
§Auckland	,, 7	10,325	+ 430	49	119,887	+ 7,817	19·24 + ·6
§Brisbane	Nov.	11,836	+1,088	..	..	..	.. ..
§Brit. Columbia Rly.	,,	20,034	+5,941	22	101,258	+18 188	.. ..
Bu'n's A'r's E.T.Co.	Dec. 1	2,948	+ 333	48	66,845	+ 9,747	24 ..
Bu'n's A'r's-Blgr'no	,, 23	7,699	+ 349	51	187,171	+10,481	.. ..
Calcutta	,, 29	8,698	+1,753	..	..	..	.. ..
§Cape Electric T. Ld.	Nov.	14,396	..	..	..	..	.. ..
§Geneva	,,	7,213	+ 221	..	..	..	.. ..
§Kalgoorlie, W.A.	,,	3,728	..	48	46,661	..	20·5 ..
Madras	Dec. 31	1,186	+ 156	52	23,229	+ 2,806	10·5 +1½
§Lisbon	Nov.	26,582	..	..	..	..	.. ..
§Mexico	Sep.	74,400	..	..	..	..	.. ..
†Perth (W.A.)	Dec. 21	1,724	+ 25	51	74,685	+ 4,024	24·25 +5

* Compared with the corresponding period of 1905. † One week only.
‡ Includes horse, steam and other receipts. § One month.

MARKET QUOTATIONS.

Wednesday, January 2nd.

CHEMICALS, &c.		Latest Price.	Fortnight's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	..
a ,, Nitric	per cwt.	22/-	..
a ,, Oxalic	per cwt.	32/-	..
a ,, Sulphuric	per cwt.	5/6	..
a Ammoniac, Sal	per cwt.	42/-	..
a Ammonia, Muriate (crystal)	per ton	£33 10	..
a ,, ,,	per ton	£30	..
a Bleaching powder	per ton	£5 10	..
a Bisulphide of Carbon	per ton	£18	..
a Borax	per ton	£15	..
a Benzole (90 %)	per gal.	10¾d.	..
a ,, (50 %)	per gal.	1/-	..
a Copper Sulphate	per ton	£32 10	£1 inc.
a Lead, Nitrate	per ton	£34 10	£3 10 inc.
a ,, White Sugar	per ton	£25	..
a ,, Peroxide	per ton	£32	..
a Methylated Spirit	per gal.	2/6	..
a Naphtha, Solvent (90 %, at 160° C)	per gal.	5/6	..
a Potassium Bichromate, in casks	per lb.	3½d.	..
a Potash, Caustic (75/80 %)	per ton	£30	..
a Potassium Cyanide	per lb.	7½d.	1½d. dec.
a Shellac	per cwt.	220/-	..
a Sulphate of Magnesia	per ton	£4 10	..
a Sulphur, Sublimed Flowers	per ton	£6 10	..
a ,, Recovered	per ton	£5 10	..
a ,, Lump	per ton	£5	..
a Soda, Caustic (white 70 %	per ton	£10 15	..
a ,, Crystals	per ton	£3 5	..
a Sodium Bichromate, casks	per lb.	3d.	..
a ,, Cyanide (basis 100 %)	per lb.	7d.	½d. dec.
METALS, &c.			
b Aluminium Ingots, in ton lots	per ton	£200	..
b ,, Wire, in ton lots	per ton	£220	..
b ,, Sheet, in ton lots	per ton	£210	..
p Babbitt's metal ingots	per ton	£62 to £207	..
c Brass (rolled metal 2" to 12") basis	per lb.	11¼d.	..
c ,, Tube (brazed)	per lb.	1/0½	..
c ,, ,, (solid drawn)	per lb.	11½d.	..
c ,, Wire, basis	per lb.	11d.	..
c Copper Tubes (brazed)	per lb.	1/2½	..
c ,, ,, (solid drawn)	per lb.	1/2½	..
g Copper Bars (best selected)	per ton	£124	£3 inc.
g Copper Sheet	per ton	£124	£3 inc.
g ,, Rod	per ton	£124	£3 inc.
e ,, (Electrolytic) Bars	per ton	£115	£6 inc.
e ,, ,, Sheets	per ton	£127	£6 inc.
e ,, ,, Rod	per ton	£117	£4 inc.
e ,, ,, H.C. Wire	per lb.	1/1½	¼d. inc.
f Ebonite Rod	per lb.	8/8	..
f ,, Sheet	per lb.	8/-	..
n German Silver Wire	per lb.	1/8	..
h Gutta-percha, fine	per lb.	6/- to 7/-	..
h India-rubber, Para fine	per lb.	5/0½ to 5/2½	½d. inc.
i Iron, Charcoal Sheets	per ton	£18	..
i ,, Pig (Cleveland warrants)	per ton	62/6	dec.
i ,, Forgings, according to size	per ton	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	..
i ,, Wire, galvanised No. 8	per ton	£9 15	..
g Lead, English Ingot	per ton	£20 2 6 to £10 5	10/- inc.
g ,, ,, Sheet	per ton	£21 12 6 to £21 15	10/- inc.
m Manganin Wire No. 28	per lb.	8/	..
g Mercury	per bot.	£7	..
d Mica (in original cases) small	per lb.	6d. to 1/-	..
d ,, ,, ,, medium	per lb.	2/6 to 4/-	..
d ,, ,, ,, large	per lb.	4/6 to 8/6	..
p Phosphor Bronze, plain castings	per lb.	1/4½ to 1/6½	½d. inc.
p ,, rolled bars & rods	per lb.	1/5½ to 1/6½	½d. inc.
p ,, ,, strip & sheet	per lb.	1/6 to 1/10	½d.—1d. inc.
o Platinum	per oz.	nominal	..
e Silicium Bronze Wire	per lb.	1/3	½d. inc.
i Steel, Magnet, acc'd'g to desc'p'n	per ton	£58	..
i ,, ,, in bars		£15 to £40	..
g Tin, Block (English)	per ton	£193 to £194	£4 dec.
n ,, Wire, Nos. 1 to 16	per lb.	2/4	..
p White Anti-friction Metals— "White Ant" brand	per ton	£61 to £88	..
k Zinc, Sh't (Vieille Montagne bnd.)	per ton	£31 15	..

Quotations supplied by:—

a G. Boor & Co.
b The British Aluminium Co., Ltd.
c Thos. Bolson & Sons, Ltd.
d F. Wiggins & Sons.
e Frederick Smith & Co.
f India-Rubber, G.P. and Teleg. Works Co., Ltd.
g James & Shakspeare.
h Edward Till & Co.
i Bolling & Lowe.
k Morris Ashby, Ltd.
m W. T. Glover & Co., Ltd.
n P. Ormiston & Sons.
o Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Co., Ltd.

STOCKS AND SHARES.

Tuesday Evening.

THE New Year brings its regular, annual crop of good resolutions for the future, and unpleasant reminders of the past. To these latter it is much to be feared that most of the following comparisons of prices will contribute. But in the New Year, as ever, things are to be much better. Human nature is always a "bull," and the hope of cheaper money gives the optimist an excellent peg upon which to hang his cheerful prophecies—the which no one will be more thankful to see fulfilled than the proprietor of Electricity Supply shares. How badly he has been buffetted by Fortune during the year now past the annexed Table shows:—

Shares.	Dec. 30, 1905.	Dec. 31, 1906.	Fall.	1906. Highest.	1906. Lowest.
Brompton and Kensington	9	7⅞	1⅛	9⅛	7⅞
Charing Cross	6¼	5⅞	2⅜	6¼	5⅝
City of London	11⅛	10	1⅛	11⅝	9⅞
County of London	9	8	1	9⅛	8
Edmundson's	5⅛	3	2⅛	5⅛	2⅝
Kensington and Knightsbridge	11⅛	9⅞	1⅛	11⅝	9⅞
Metropolitan	10	7⅞	2⅛	10⅛	7⅛
Notting Hill	14⅛	14	⅛	14⅛	13⅝
St. James'	13⅞	10	3⅞	13⅛	9⅞
Urban	4⅜	3⅜	1⅛	4⅛	3⅛
Westminster	12	9⅞	2⅛	12⅛	9

Developments in electric traction have been one of the main features of the railway year. The great trunk lines are finding adoption of the system a growing necessity for their short-distance traffic. But the purely electrical railway companies, and the two "undergrounds" have little cause to thank 1906 so far as the quotations for their securities are concerned. Here are some representative prices:—

Stock.	Dec. 30, 1905.	Dec. 31, 1906.	Fall.	1906. Highest.	1906. Lowest.
Central London Ordinary	94⅛	83	11⅛	96⅛	82½
,, Deferred	86⅛	73½	13	89	72
City and South London	45	42	3	47½	39
Great Northern and City Pref.	5⅛	3½	1⅝	5⅝	3 5/16
Metropolitan	87	60	27	89⅞	59
Metropolitan District	35½	19	16½	37⅞	18⅜
Waterloo and City	95½	101½	+6	102½	94

Efforts to vary this monotonous iteration of declines, cause a hunt amongst Telegraph securities for more cheerful reading. The search reveals a partial reward, but changes are irregular. While American issues have improved, the Eastern varieties exhibit nasty declines, as these figures show:—

Stock or share.	Dec. 30, 1905.	Dec. 31, 1906.	Rise or fall.	1906. Highest.	1906. Lowest.
Anglo Preferred	110	109	− 1	115½	107½
,, Deferred	17⅞	27⅝	+10⅛	27⅞	16⅝
Cuba Submarine	8⅜	8⅜	—	9⅞	8⅜
Direct U.S.	14⅜	15½	+ 1⅛	17	14⅜
Eastern Extension	14⅜	13⅜	− 1⅛	15⅛	12⅞
Eastern Telegraph	145⅛	136½	− 9	150⅜	130⅛
Great Northern	37⅛	36½	− 1	41	35⅞
Indo-European	58	59	+ 1	60⅜	56⅛
Western Telegraph	14	13⅜	− ¼	15	13½

Within the same period National Telephone Preferred stock has fallen from 111 to 108, and the Deferred from 109 to 106½, declines of 3 and 2½ respectively. In the first half of the year the Deferred stock was run up to 113¾, and the Preferred to a point higher.

New undertakings have formed a feature in the electric traction department. While the more familiar issues are lower in popular favour and in price, extensive dealings are now taking place in electric traction, lighting and power companies formed to operate in various Canadian, Mexican, Brazilian and other cities. For purposes of comparison, we must confine our statistics to stocks and shares in the older undertakings:—

Stock or share.	Dec. 30, 1905.	Dec. 31, 1906.	Fall.	1906. Highest.	1906. Lowest.
Anglo-Argentine Ordinary	8¼	7 1/16	3/16	9⅛	6½
British Columbia Electric Def.	121½	129½	+ 8	129½	115
British Elec. Traction Ordinary	8½	4⅜	4⅛	8⅜	3 5/16
,, ,, Preference	10⅜	8½	2	11½	7⅛
Cape Electric	1	⅜	⅝	1 1/16	⅜
London United Preference	9⅜	8⅜	1	10	7⅜
Metropolitan Electric Preference	1 3/32	3/32	1/16	1 1/16	1/16

It may be added, as a matter of motor-'bus interest, that the Ordinary shares in the "Vanguard" Company are now £1, which is 17s. 6d. lower than they were a year ago.

Industrial shares have, amongst other changes, the ensuing alterations, upon which it seems scarcely necessary to comment.

Share.	Dec. 30, 1905.	Dec. 31, 1906.	Fall.	1906. Highest.	1906. Lowest.
British Insulated	6⅜	6⅜	—	7½	6⅛
British Westinghouse Preference	2	1⅜	⅝	2⅛	1⅜
Callender's	11⅛	10	1⅛	11⅜	9⅛
Electric Construction	⅜	⅛	¼	⅜	⅛
Edison & Swan	1⅜	1⅜	—	1⅜	1⅜
Henley's	13	11½	1½	13⅜	11
India-Rubber	18½	16½	2	19	17
Telegraph Construction	33	31	2	36	30

Taken altogether, it will be seen that the results of the year's working are written mainly in the minor. Money has been pitched in a particularly high key, with a 6 per cent. Rate as the Bank of England's top note. The New Year overture opens to this shrill accompaniment, and all the markets look for their improvement to an early modification of such a disturbance to financial harmony.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last four years. 1903.	1903.	1904.	1905.	Closing Quotations Dec. 18th.	Closing Quotations Jan. 1st,	Business done fortnight ended Jan. 1st, 1907. Highest	Lowest.	Rise + or Fall —
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	Nil	Nil	Nil	..	3 — 3½	3 — 3¼	..	..	..
149 600	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	Nil	Nil	Nil	5 %	88 — 93	86 — 91 xd	..	..	..
660,660	Anglo-American Telegraph	Stock	60/6	61s.	22½	3½	66 — 68	67 — 69	..	..	+ 1
3,169,670	Do. do. do. 6 % Pref.	Stock	6 %	6 %	5½	6 %	108 —109	108½ —109½	108¾	108¼	+ ½
3,169,670	Do. do. do. Deferred	Stock	1/-	2s.	Nil	½	26 — 26½	27½ — 28	28	25/8	+ 2½
50,000	Anglo-Portuguese Tel., 5 % Mort. Deb. Stock Red.	100	..	..	..	..	102 —104	101 —103	..	..	— 1
44,000	Chili Telephone, Nos. 1 to 44,000	5	6 %	7 %	8 %	8 %	6¾ — 7¼	6¾ — 7¼	..	..	..
2,097,680	Commercial Cable Siing. 500 year 4 % Deb. Sk. Red.	Stock	4 %	4 %	4 %	4 %	97 — 99	96 — 98 xd	98½	98	..
15,000	Cuba Telegraph	10	6¾	10 %	5 %	5 %	8¾ — 9	8¾ — 9	..	..	..
6,000	Do. 10 % Pref.	10	10 %	5 %	10 %	10 %	17 — 18	17 — 18	..	..	..
12,981	Direct Spanish Telegraph, Ord.	5	4 %	4 %	4 %	4 %	8⅜ — 8¾	8⅜ — 8¾	..	..	..
6,000	Do. do. 10 % Cum. Pref. ..	5	10 %	10 %	10 %	10 %	9 — 9½	9 — 9½	..	..	..
20,000	Do. do. 4½ % Debs.	50	4½ %	4½ %	4½ %	4½ %	0 —103	100 —103	..	..	..
80,710	Direct United States Cable	20	8½	8	8½	4½	15½ — 15⅝	15⅝ — 16	15⅞	15⅝	+ ⅛
60,500	Direct W. India Cable, 4½ % Reg. Deb., 1 to 1,200, R.	100	4½ %	4½ %	4½ %	4½ %	101 —103	99 —101 xd	..	..	..
4,900,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	7 %	132 —137	134 —139	137	134½	+ 2
2,000,000	Do. 8½ % Pref. Stock	100	8½ %	8½ %	8½ %	8½ %	88 — 90	87 — 89	87	..	— 1
1,896,706	Do. 4 % Mort. Deb. Stock Red. ..	Stock	4 %	4 %	4 %	4 %	105½—107½	106 —107	105½	..	+ ½
800,000	Eastern Extension, Australasia, and China Tels.	10	7 %	7 %	7 %	7 %	13¾ — 13⅞	13½ — 13⅝	13½	..	+ ⅛
763,400	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %	105½—107½	105½—107½	..	..	..
295,400	East & S. Afric. Tel., 4 % Mt. Db., 1 to 3,000, red. 1909	100	4 %	4 %	4 %	4 %	99 —101	99 —101	..	..	..
200,000	Do. 4 % Reg. M. Debs. (Mauritius Sub.) 1 to 3,000	25	4 %	4 %	4 %	4 %	99 —101	99 —101	..	..	..
181,127	Globe Telegraph and Trust	10	£3	5½ %	5⅝ %	5½ %	10 — 10½	10 — 10½	10⅝	10 1/16	..
121,127	Do. do. 6 % Pref	10	6 %	6 %	6 %	6 %	14 — 14½	14 — 14½	14⅜	14	..
150,000	Great Northern Telegraph, of Copenhagen ..	10	12½%	15 %	24 %	24%	35½ — 37½	35½ — 37½	..	..	..
33,500	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,300, Red.	100	4½%	4½%	4½%	4½%	100½—102½	99 —101 xd	..	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	12 %	13 %	58 — 60	58 — 60	..	..	..
226,127	Marconi's Wireless Telegraph	1	Nil	Nil	Nil	Nil	13/16 — 15/16	13/16 — 15/16	..	..	..
72,630	Monte Video Telephone Co., Ltd. Ord.	1	8 %	8 %	4 %	5 %	1 — 1⅛	1 — 1⅛	20/-	..	..
86,492	Do. do. do. 5 % Pref. ..	1	5 %	5 %	5 %	5 %	1 — 1	1 — 1	..	..	..
2 225 000	National Telephone, Pref. Stock	100	6 %	6 %	6 %	6 %	107 —109	107 —109	108½	107¾	..
2,225 000	Do. do. Def. Stock	100	4½%	5 %	5 %	5 %	105 —107	105½—107½	107	106¾	+ ½
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	6 %	11 — 13	11 — 13	..	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	6 %	10 — 12	10 — 12	..	..	..
250,000	Do. do. 5 % Non-cum. 3rd P., 1 to 250,000	5	5 %	5 %	5 %	5 %	5½ — 5¾	5½ — 5¾	5⅝	..	..
3,000,000	Do. do. 3½ % Deb. Stock Red. ..	Stock	3½%	3½%	3½%	3½%	96 — 98	94½ — 96½ xd	..	..	..
1,689,598	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	101½ —103½	100 —102 xd	..	..	..
179,313	Oriental Telep. and Elec. 1 to 171,504, fully paid	1	6 %	6½%	6½%	7½%	1½ — 1⅝	1½ — 1⅝	2/-	..	..
50,000	Do. do. do. 6 % Cum. Pref. ..	1	6 %	6 %	6 %	6 %	1⅜ — 1½	1⅜ — 1½	..	..	..
100,000	Do. do. do. 4% Red. Deb. Stock	100	..	..	..	4 %	97 — 99	95 — 97 xd	..	..	..
100,000	Pacific & European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	4 %	4 %	4 %	99 —102	98 —101 xd	..	..	..
11,889	Reuter's	8	5 %	5 %	5 %	5 %	7½ — 7¾	7½ — 7¾	..	..	..
60,000	Telephone Co. of Egypt, 4½ % Deb. Red.	100	..	..	..	4½%	101 —104	99 —102 xd	..	..	..
8,167	Submarine Cables Trust	Certs.	6 %	6 %	6 %	6 %	126 —129	126 —129	..	..	..
80,000	United River Plate Telephone	5	7 %	8 %	8 %	8 %	6⅝ — 7⅜	6⅞ — 7⅛ xd	..	..	..
40,000	Do. 5 % Cum. Pref., Nos. 1 to 40,000	5	5 %	5 %	5 %	5 %	5⅛ — 5⅜	5⅛ — 5⅜ xd	..	..	..
179,947	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	5 %	110 —113	108 —111 xd	..	..	..
15,600	West African Telegraph, Shares	10	2 %	4 %	4½%	4 %	10 — 10½	10 — 10½	..	..	..
80,008	W. Coast of America, 1 to 80,000 & 58,001 to 58,008	2½	Nil	Nil	Nil	Nil	2/16 — 3/16	2/16 — 3/16	..	..	..
150,000	Do. 4 % Debs., 1 to 1,500 guar. by Bras. Sub. Tel.	100	4 %	4 %	4 %	4 %	100½ - 103½	100½ —103½	..	..	..
207,980	Western Telegraph, Ltd., Nos. 1 to 207,930 ..	10	7 %	7 %	7 %	7 %	13½ — 14	13½ — 14 xd	13½	13⅜	..
800,000	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	101 —104	99 —102 xd	101	..	..
88,821	West India and Panama Telegraph	10	Nil	Nil	Nil	..	1/16 — 2/16	1/16 — 2/16	..	..	..
84,568	Do. do. 6 % Cum. 1st Pref.	10	7 %*	7 %*	6 %	5 %	7½ — 7¾	7½ — 7¾	..	..	..
4,669	Do. do. 6 % Cum. 2nd Pref.	10	Nil	Nil	Nil	Nil	5½ — 6¼	5½ — 6¼	6	..	..
80,000	Do. do. 5 % Debs., Nos. 1 to 1,800 ..	100	5 %	5 %	5 %	5 %	101 —104	99 —102 xd	..	..	..

Including arrears.

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

270,000	Anglo-Argentine Trams, Nos. 260,008 to 510,007, and 560,008 to 580,007	5	..	..	8 %	8 %	7 7/16 — 7 11/16	7 7/16 — 7 11/16	7 3/4	7½	+ ⅛
260,007	Do. 5½ % Cum. Prefs., 1 to 260,007 ..	5	..	5 %	5 %	5½%	5 5/16 — 5 11/16	5½ — 5⅝xd	5 11/16	5⅝	..
266,600	Do. Permanent, 6 % Deb. Stock, 1888	100	..	6 %	6 %	6 %	139 —142	136 —139 xd	..	..	..
265,100	Auckland E. Trams., 5 % 1st Mort. Deb. Stock ..	100	..	5 %	5 %	5 %	104 —106	102 —104 xd	..	..	..
880,000	Babcock & Wilcox, 1 to 880,000	1	..	17 %	20 %	20 %	3¾ — 4¼	3¾ — 4¼	80/7½	80/6	..
100,000	Do. do. 6 % Cum. Pref., 1 to 100,000 ..	1	..	6 %	6 %	6 %	1 7/16 — 1 9/16	1 7/16 — 1 9/16	..	..	..
88,000	British Aluminium, Ord., 2,001 to 40,000	5	..	..	7 %	7 %	6 13/16 — 6¾	6 — 6¼	..	..	+ ⅛
45,000	Do. do. 7 % Cum. Pref...	5	Nil	Nil	7 %	7 %	6¾ — 6¾	6¼ — 6¾	6 1/32	..	..
20,000	Do. do. "A" 6 % Cum. Pref.	5	Nil	Nil	6 %	6 %	5¼ — 5½	5¼ — 5½	..	..	..
20,000	Do. do. 4 % Funding Certs.	5	..	..	4 %	4 %	4 — 4¼	4 — 4¼	..	..	..
258,000	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	5 %	5 %	5 %	5 %	101 —105	101 —105	..	..	..
800,000	Do. do. 5½ % Loch Leven Debs. ..	100	..	..	..	..	100 —103	100 —103	..	..	..
400,000	British Columbia E. Rail Def. Ord. Stock	100	..	6 %	6 %	6 %	127 —132	127 —132	130½	129	..
400,000	Do. 5 % Pref. Ord. Stock	100	..	5 %	5 %	5 %	108 —112	108 —112	110½	..	..
800,000	Do. 5 % Cum. Perp. Pref. Stock	100	..	5 %	5 %	5 %	107 —110	107 —110	109¼	..	..
232,000	Do. 4½ % 1st Mort. Debs., 1 to 5,250	40	..	4½%	4½%	4½%	102 —105	102 —105	..	..	..
200,000	Do. 4½ % Vancouver Power Debs., 1 to 2,000	100	..	4½%	4½%	4½%	102 —105	102 —105	..	..	..
132,901	British Electric Traction	10	8 %	6 %	6 %	8 %	4¼ — 4⅜	4¼ — 4⅜	88/9	..	—
161,497	Do. do. 6 % Cum. Pref.	10	6 %	6 %	6 %	6 %	8¼ — 8⅜	8⅜ — 8½	8¼	8⅜	..
1,442,653	Do. do. 5 % Perp. Deb. Stock ..	Stock	5 %	5 %	5 %	5 %	107 —110	108 —111	110	109	+ 1
210,178	Do. do. 4½ % 2nd Deb. Stock Red.	100	..	..	4½%	4½%	85 — 88	85 — 88	86⅜	..	..
100,000	British Insulated and Helsby Cables	5	10 %	8 %	8 %	8 %	6¾ — 7	6¾ — 7	6⅞	..	..
100,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	6 %	6⅝ — 6¾	6⅝ — 6¾	..	..	..
800,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	4½%	4½%	4½%	4½%	102 —105	100 —103 xd	..	..	..
212,000	British Thomson-Houston 4½ % 1st Mort. Debs. ..	100	..	4½%	4½%	4½%	94 — 98	94 — 98	..	..	..
400,000	British Westinghouse 6 % Pref., 1 to 200,000 and 275,001 to 475,000	5	..	6 %	Nil	..	1½ — 2	1⅜ — 1⅞	..	..	— ⅛
1,016,356	Do. do. 4 % Mort. Deb. Stock ..	100	..	4 %	4 %	4 %	73 — 77	73 — 77	..	..	..
60,000	¶Browett, Lindley & Co., Ord.	£1	Nil	Nil	Nil	..	7/8 — 1 1/16	7/8 — 1 1/16	..	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	Nil	Nil	Nil	..	14/6 to 15/6	14/6 to 15/6	..	..	..
105,781	Brush Electrical Engineering, Ord., 1 to 105,781 ..	2	Nil	Nil	Nil	2½%	1 — 1 1/16	1 — 1	..	..	..
150,000	Do. Non-cum. 6 % Pref... ..	2	6 %	6 %	6 %	6 %	1⅜ — 1½	1⅜ — 1½	..	..	..
125,000	Do. 4½ % Perp. Deb. Stock ..	Stock	4½%	4½%	4½%	4½%	95 — 97	95 — 97	..	..	..
125,000	Do. 4½ % Perp. 2nd Deb. Stock	Stock	4½%	4½%	4½%	4½%	82 — 85	80 — 83 xd	..	..	..
100,000	Buenos Ayres & Belgrano, 1 to 100,000	5	..	3 %	4 %	3 %	3 — 3¼	3 — 3¼	..	..	..
40,000	Do. "A" 6 % Cum. Pref., 1 to 40,000	5	..	6 %	6 %	6 %	5¼ — 5½	5¼ — 5½	5	..	..
27,500	Do "B" do. 1 to 27,500	5	..	6 %	6 %	6 %	4¼ — 4½	4¼ — 4½	..	..	..
318,200	Do. 5 % Deb. Stock	100	..	5 %	5 %	5 %	105 —107	104 —106 xd	..	..	..
200,000	Do. 5 % 2nd Deb. Stock	100	..	5 %	5 %	5 %	102 —105	101 —104 xd	..	..	..
106,000	Calcutta Trams., 1 to 105,000	5	..	6 %	8 %	8 %	7⅜ — 8⅜	7⅜ — 8⅜	..	..	..
82,610	Do. 105,001 to 187,610	5	..	..	..	8 %	7⅜ — 8⅜	7⅜ — 8¼xd	..	..	..
30,000	Do. 5 % Cum. Pref., Nos. 1 to 29,350 ..	..	..	..	..	..	5¼ — 5⅝	5¼ — 5⅝xd	..	..	..
860,000	Do. 4½ % 1st Deb. Stock	100	..	4½%	4½%	4½%	103 —106	103 —106 xd	..	..	..
85,000	Callender's Cable Construction shares	5	15 %	12½%	12½%	15%	9½ — 10⅜	9⅜ — 10⅜	10¼	..	..
40,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	6¼ — 6⅜xd	6⅛ — 6⅜	6⅜	..	..
800,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	103½—110½	106 —108 xd	..	..	..
491,222	Cape E. Trams., 1 to 491,222	1	15 %	10 %	5 %	Nil	7/16 — 9/16	7/16 — 7/16	10/-	..	..
450,000	Castner-Kellner Alkali, 1 to 450,000	1	..	4 %	4 %	6 %	1 3/32 — 1 5/32 xd	1 3/32 — 1 5/32	22/6	..	..
224,988	Do. do. 4½ % 1st Mort, Deb. Stock	100	..	4½%	4½%	4½%	97 —102	97 —102	..	..	..
1,911,568	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	4 %	83 — 85	82 — 84	84	82⅞	— 1
544,216	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	4 %	98 —100	98 —100	..	..	..
544,216	Do. do. Def. do.	Stock	4 %	4 %	4 %	4 %	72 — 75	72 — 75	..	..	..
1,250,000	City and South London Railway	Stock	3½%	3½%	3½%	1½%	41 — 43	42 — 44	43	41	+ 1
85,000	Crompton & Co., Nos. 1 to 85,000	5	5 %	2½%	2½%	2½%	1½ — 1⅝	1½ — 1⅝	..	..	..
100,000	Do. 5 % 1st Mort. Reg. Debs., 1 to 800 of £100, and 801 to 11,000 of £50 Red.	..	5 %	5 %	5 %	5 %	94 — 97	94 — 97	..	..	..

* A period of nine months. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § Interim dividends.
‖ And bonus of 10s. ¶ From Manchester Share List.

(Continued on next page.)

SHARE LIST OF ELECTRICAL COMPANIES.—*(Continued.)*

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.—*(continued).*

Present Issue.	NAME.	Stock or Share.	Dividends for the last four years. 1903.	1903.	1904.	1905.	Closing Quotations Dec. 18th.	Closing Quotations Jan. 1st.	Business done fortnight ended Jan. 1st, 1907. Highest	Lowest.	Rise + or Fall—
250,000	Dick, Kerr & Co., 1 to 250,000	1	..	..	10 %	10 %	1⅜ — 1⅝	1⅜ — 1⅝	..	..	..
305,000	Do. do. 6 % Cum. Pref., 1 to 305,000	1	..	6 %	6 %	6 %	1⅜ — 1½	1⅜ — 1½	..	..	..
224,150	Do. do. 4½ % Deb. Stock	100	..	4½ %	4½ %	4½ %	103 —106	101 —104 xd	..	..	..
60,000	Dublin United Trams. (1896), 1 to 60,000	10	..	5½ %	6 %	6 %	14 — 15	14 — 15	..	..	..
59,987	Do. 6% Pref. between 1 and 60,000	10	..	6 %	6 %	6 %	14 — 15	14 — 15	..	..	..
99,261	Edison & Swan Utd., "A" shrs., £3 pd., 1 to 99,261	5	Nil	Nil	2½ %	4⅓ %	1⅜ — 1⅝	1⅜ — 1⅝	..	..	— ⅛
17,189	Do. "A" shares, 01—017,189	5	Nil	Nil	2½ %	4⅓ %	2⅛ — 2⅜	2⅛ — 2⅜	..	..	..
319,475	Do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	86 — 88	85 — 87 xd	..	..	..
72,220	Do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	5 %	5 %	5 %	5 %	90 — 95	90 — 95	91	90½	..
112,100	Electric Construction 1 to 112,100	2	6 %	4 %	Nil	Nil	¼ — 7/16	¼ — 7/16	..	..	..
81,890	Do. do. 7 % Cum. Pref., 1 to 81,890	2	7 %	7 %	7 %	7 %	1½ — 2	1½ — 2	..	..	..
200,000	Do. do. 4 % Perp. 1st Mort. Deb. Stk.	Stock	4 %	4 %	4 %	4 %	83 — 86	83 — 86	..	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	5 %	5 %	9 — 9⅛	9/16 — 5/8 xd	..	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	4 %	4 %	4 %	4 %	94 — 97	94 — 97	..	..	..
78,000	Gt. N. & City Rail Pref. Ord. "A" 4 % 1 to 78,000	10	..	3 %	4 %	4 %	3½ — 3⅝	3½ — 3⅝	..	..	..
96,000	Greenwood & Batley 7 % Cum. Pref.	10	..	7 %	7 %	7 %	10½ — 10¾	10½ — 10¾	..	..	..
80,000	Do. do. 5 % Mort. Debs.	100	..	5 %	5 %	5 %	102 —103	102 —103	..	..	..
200,000	Henley's (W. T.), Telegraph Works, Ord.	5	20 %	15 %	15 %	15%	11 — 12	11 — 12	11⅜	11	..
200,000	Do. do. 4½ % Pref.	5	4½ %	4½ %	4½ %	4½ %	5 5/16 — 5 7/16	5 5/16 — 5 7/16	..	..	..
150,000	Do. do. 4½ Mort. Deb. Stock	Stock	4½ %	4½ %	4½ %	4½ %	106 —108	106 —108	107½	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works.	10	10 %	10%	5 %	10%	17 — 18	16 — 17 xd	16½	..	..
87,500	Liverpool Overhead Railway, Ord.	10	1½%	18%	1½%	Nil	1⅜ — 1⅝	1⅜ — 1⅝	..	..	..
10,000	Do. do. Pref. £10 paid	10	5 %	5 %	5 %	5 %	6 — 7	6 — 7	..	..	..
600,070	London United Trams (1901), 1 to 50,007	10	..	8 %	6 %	3 %	8½ — 9	8 — 9	8 1/16	8⅞	..
899,930	Do. do. 60,008 to 100,000 (£6 paid)	10	..	8 %	6 %	3 %	3½ — 4½	3½ — 4½	..	..	..
125,000	Do. do. 5 % Cum. Pref., 1 to 125,000	10	..	5 %	5 %	5 %	8 — 9	8 — 9 xd	..	..	..
1,331,000	Do. do. 4 % 1st Mort. Deb. Stock	100	..	4 %	4 %	4 %	88 — 93	88 — 91 xd	..	..	..
314,016	Metropolitan Electric Trams, Defd.	1	Nil	Nil	Nil	3 %	1/16 — ⅛	1/16 — ⅛	..	..	..
500,000	Do. 5 % Cum. Pref.	1	5 %	5 %	5 %	5 %	25/32 — 13/16	25/32 — 13/16	..	..	..
350,000	Do. 4½ % Deb. Stock Red.	100	..	..	4½ %	4½ %	97 —100	95 — 98 xd	98	..	..
30,000	Peebles (B.) & Co. 6 % Cum. Pref., 20,001 to 50,000	5	..	..	6 %	6 %	4 3/16—4 5/16	4 3/16—4 5/16	..	..	..
24,500	Potteries E. Trc., 20,001 to 40,000 & 50,001 to 54,500	10	..	5 %	5 %	4 %	6 — 7	6 — 7	..	..	..
24,500	Do. 5 % Cum. Pref., 1 to 20,000 & 40,001 to 44,500	10	..	5 %	5 %	5 %	7½ — 8½	7 — 8	..	..	— ½
245,000	Do. 4½ % Deb. Stock	100	..	4½ %	4½ %	4½ %	98½—101½	98½—101½	..	..	..
37,350,	Telegraph Construction and Maintenance	12	20 %	20 %	15 %	15 %	30 — 32	30 — 32	..	..	..
150,000	Do. 4 % Deb. Bds., 1 to 1,500 Red. 1909	100	4 %	4 %	4 %	4 %	100 —102	100 —103	..	..	+ ½
8,599,200	Undergd. E. R., Lon., 5 % Profit Shar. S. Nts.	..	..	..	..	5 %	8) — 91	8) — 91	..	..	..
540,000	Waterloo & City Railway, Ord. Stock	100	3½%	3½%	3½%	3½%	100 —103	100 —103	..	..	..
66,666	Willans & Robinson, 1 to 30,000 & 80,001 to 116,666	5	8½%	8 %	Nil	Nil	1 — 1⅛	1 — 1⅛	..	..	..
66,666	Do. 6 % C. P., 30,001 to 80,000 & 125,001 to 141,666	5	..	6 %	Nil	Nil	2⅛ — 3	2⅞ — 3⅛	..	..	+ ⅛
246,574	Do. 4 % 1st Mort. Deb. Stock	100	..	4 %	4 %	4 %	78 — 78	74 — 79	74	..	+1

ELECTRICITY SUPPLY COMPANIES.

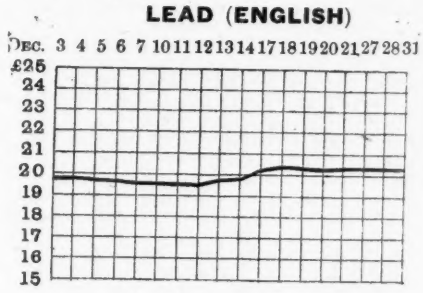
14,000	Bromley (Kent) E.L. & P., 1 to 14,000	5	..	5 %	5½%	4 %§	5 — 5⅛	5 — 5⅛	..	..	..
71,000	Do. do. 4½ % 1st. deb. stock	100	..	4½ %	4½%	4½%	99 —101	99 —101	..	..	..
29,798	Brompton & Kens. Elec. Lt. Sup., Ord., 1 to 20,000	5	8 %	10 %	10 %	10 %	8 — 9	8 — 9	..	..	..
.0, 02	Do. do. 7 % Cum. Pref.	5	7 %	7 %	7 %	7 %	7⅛ — 8	7⅛ — 8	..	..	..
336,876	Central Electric Supply 4 % Guar. Deb. Stock	100	4 %	4 %	4 %	4 %	101 —104	101 —104	..	..	..
80,000	Charing Cross and Strand Electricity Supply	5	10 %	8 %	8 %	5 %	3½ — 4½	3½ — 4½	..	..	..
80,000	Do. do. do. 4½ % Cum. Pref.	5	4½%	4½%	4½%	4½%	4½ — 4⅝	4½ — 4⅝	..	..	..
80,000	Do. "City Undertaking" 4½ % Cum. Prf.	5	4½%	4½%	4½%	4½%	3⅝ — 4⅛	3⅝ — 4 xd	..	..	..
427,400	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	100 —103 xd	100 —103	..	..	..
49,426	Chelsea Electricity Supply, Ord.	5	4½%	5½%	6 %	6 %	5⅛ — 5⅜	5⅛ — 5⅜	..	..	..
175,000	Do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	106 —109	104 —107 xd	..	..	..
70,595	City of London Elec. Lighting, Ord. 40,001—110,595	10	5 %	5 %	6 %	6 %	9⅛ — 10⅛	9⅛ — 10⅛	10⅛	10	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	6 %	11 — 12	11 — 12	..	..	..
400,000	Do. 5 % Db. Stk., Scrip. (iss. at 115) all pd.	..	5 %	5 %	5 %	5 %	123 —126	121 —124 xd	..	..	..
800,000	Do. 4½ % 2nd Db. Stk., Prov. Crts., all pd.	100	4½%	4½%	4½%	4½%	100 —103	99 —102 xd	..	..	..
40,000	County of Durham Electrical Power, Ord.	2	4 %	4 %	£3 7 0	4 %	2⅛ — 3 3/16	2⅛ — 3 3/16	..	..	..
50,000	Do. do. do. 5 % Pref.	5	5 %	5 %	5 %	5 %	5 — 5⅛	5 — 5⅛	..	..	..
43,000	County of London Electric Lighting, Ord. 1—40,000	10	4 %	4 %	4½%	5 %	7⅛ — 8⅛	7⅛ — 8⅛	..	..	..
40,000	Do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	6 %	10⅛ — 11⅛	10⅛ — 11⅛	..	..	..
400,000	Do. do. 4½ % Deb. Stock	..	4½%	4½%	4½%	4½%	107 —110	105 —108 xd	..	..	..
400,000	Do. do. 4½ % 2nd Deb. Stock	Stock	4½%	4½%	4½%	4½%	98 —101	98 —101	98	..	..
80,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	7 %	4 %	2⅜ — 3½	2⅛ — 3⅛	..	..	..
80,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	6 %	4½ — 5½	4½ — 5½	100/-	97/6	..
320,000	Do. do. 4½ % 1st Mort Deb. Stk	100	4½%	4½%	4½%	4½%	99 —102	99 —102	99	..	..
10,000	Folkestone, 1 to 10,000	5	..	5½%	5½%	5½%	5½ — 5⅝	5½ — 5⅝	..	..	..
10,000	Do. 5 % Cum. Pref., 1 to 10,000	5	..	..	..	5 %	4⅛ — 5⅛	4⅛ — 5⅛	..	..	..
90,000	Do. 4½ % 1st. Deb. Stock	100	..	4½%	4½%	4½%	99 —102	99 —102	..	..	..
15,000	Hove, 1 to 15,000	5	..	8½%	8½%	9 %	7⅜ — 8½	7⅜ — 8½	..	..	..
21,000	Kensington and Knightsbridge Electric Ord.	5	10 %	12%	12 %	10 %	9½ — 10½	9½ — 10½	..	..	..
90,000	Do. do. do. 4 % Deben. Stk.	Stock	4 %	4 %	4 %	4 %	99 —102	99 —102	..	..	..
111,000	London Electric Supply Corporation, Limited, Ord.	3	Nil	Nil	3 %	4 %	1⅜ — 2⅛	1⅜ — 2⅛	..	..	..
70,000	Do. do. do. 6 % Pref.	5	6 %	6 %	6 %	6 %	4⅜ — 5⅛	4⅜ — 5⅛	5 5/32	1/8	..
8,12,696	Do. do. 4 % 1st Mort. Deb. Stk. Red.	Stock	4 %	4 %	4 %	4 %	95 — 98 xd	95 — 98	96½	..	..
200,000	Metropolitan Electric Supply, 1 to 100,000	5	7½%	8½%	10 %	10 %	7 — 8	7 — 8	7⅛	7½	..
76,121	Do. 4½ % Cum. Pref. 1—71,106, £3 pd.	5	4½%	4½%	4½%	4½%	5⅛ — 5⅝	5 1/16 — 5 5/16 xd	5 1/16	..	..
250,000	Do. 4½ % 1st Mort. Deben. Stock	..	4½%	4½%	4½%	4½%	108 —112	106 —110 xd	..	..	..
250,000	Do. 3½ % Mort. Deben. Stock Redem.	Stock	3½%	3½%	3½%	3½%	95 — 97	94 — 96 xd	..	..	..
250,000	Midland Electric Corporation, 4½ % 1st Mort. Deb.	100	4½%	4½%	4½%	4½%	98 —101	96 — 99 xd	99½	..	..
67,991	Newcastle-on-Tyne	5	..	8 %	8 %	8 %	7⅝ — 8	7⅝ — 8	..	..	..
70,000	Do. 5 % Pref., 1 to 70,000	5	..	5%	5 %	5 %	5⅝ — 6⅛	5⅝ — 6⅛	..	..	..
10,852	Notting Hill Electric Lighting	10	6 %	6 %	7 %	7⅝%	13⅜ — 14½	13⅜ — 14½	..	..	..
64,000	Do. do. 4 % 1st Mort. Deb.	100	4 %	4 %	4 %	4 %	97 —100	97 —100	..	..	..
20,000	Oxford, 1 to 96 and 407 to 20,310	5	..	6½%	7 %	7 %	6 — 6½	6 — 6½	..	..	..
80,000	Do. 4 % Deb. Stock	100	..	4 %	4 %	4 %	98 —100	98 —100	..	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	12½%	9½ — 10½	9½ — 10½	9⅝	9½	..
20,000	Do. do. 7 % Pref. 20,081 to 40,080	5	7 %	7 %	7 %	7 %	7 — 8	7 — 8	..	..	..
150,000	Do. do. 3½ % Deb. Stock Red.	100	3½%	3½%	3½%	3½%	95 — 97	94 — 96 xd	..	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	2½%	4 %	4 %	4 %	1½ — 2⅛	1½ — 2⅛	..	..	..
50,000	Do. do. do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %	73 — 77	73 — 77	..	..	..
65,000	South London Electricity Supply, Ord.	5	12½	3 %	4 %	4 %	2⅜ — 3⅛	2⅜ — 3⅛	..	..	..
122,000	South Met. Elec. Lt. & Power, Ord.	1	Nil	Nil	Nil	2½%	1/16 — 1/8	1/16 — 3/16	..	..	+ 1/16
117,988	Do. Do. 7 % Pref.	1	Nil	7 %	7 %	7 %	1⅛ — 1⅜	1⅛ — 1⅜	14/-	..	..
200 000	Do. Do. 4½ % 1st Deb. Stk.	100	4½%	4½%	4½%	4½%	102 —105	102 —105	..	..	..
80,000	Urban Electric Supply, Ord.	5	5 %	5 %	5 %	5 %	3⅛ — 3⅝	2⅛ — 3⅝	..	..	..
50,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	4 — 4½	4 — 4½	..	..	..
200,000	Do. do. 4½ % 1st Mort. Db. Stk. Red	100	..	..	4½%	4½%	99 —102	99 —102	..	..	..
110,000	Westminster Electric Supply, Ord.	5	12 %	15½%	14 %	15 %	9 — 10	9 — 10	9½	9⅝	..
81,279	Do do. 4½ % Cum. Pref. (Originally 5%—Red. to 4½ % from 31st Dec., 1905.	5	5 %	5 %	5 %	5 %	6⅛ — 6⅜	6 — 6½ xd	5⅝	..	..

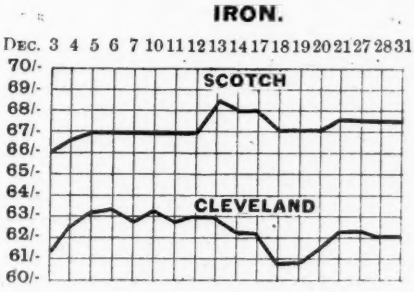
Shares not officially quoted:—Mackay Companies, ord., 73—75. Pref. 70—72.
† Unless otherwise stated all shares are fully paid. § Interim dividends.

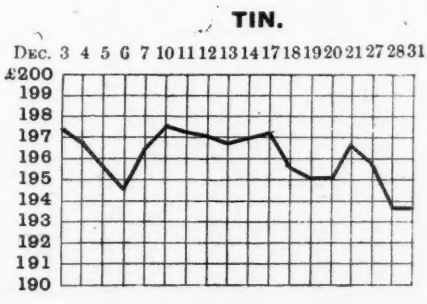
(Bank rate of discount 6 per cent. October 19th, 1906.

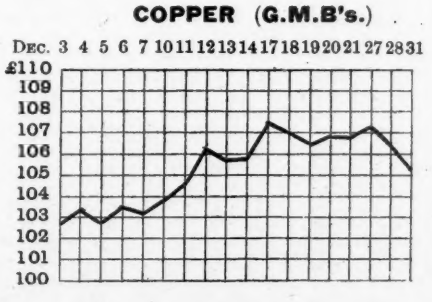
METAL MARKET.

Fluctuations in December, 1906.









A New Organisation.—On the opening morning of the New Year we received intimation of the birth of a new organisation under the title of Wholesale Electric Traders, "consulting experts and trade organisers," whose offices are at 2, Queen Anne's Gate, Westminster, S.W. The main object of the organisation—of which Mr. C. S. Northcote, M.I.E.E., is chairman and general manager—is to bring together for mutual benefit the many and varied interests of the electrical trade, profession and existing associations. We hope shortly to be able to give some further information on the matter.

PROCEEDINGS OF INSTITUTIONS.

Cheapened Methods of Electrical Distribution.

By J. H. C. Brooking, A.M.I.E.E.

(*Abstract of Paper Read before the* Institution of Electrical Engineers *at Manchester, December 18th*, 1906.)

The methods which have been recently used for the cheapening of electrical distribution may be summarised as follows:—

1. Overhead wires.
2. Increasing the current capacity.
3. Utilising tramway wires.
4. Unarmoured cables laid in ground.
5. Cables laid through blocks of houses.

Also the wiring of houses upon insulators, and the abolishing of meters for lower capital cost in the houses themselves.

1. *Overhead Mains.*—Until quite recently many central station engineers and consultants would not use this class of work under any consideration, and stood in awe of the Board of Trade as the official spoiler of overhead mains schemes. The Board of Trade, however, does not deserve this stigma. Its revised rules for overhead line construction may be somewhat grandmotherly in intention, but it is a simple matter to persuade it to agree to such lines, providing you can prove the necessity, and can satisfy the Board that your designs are either in accordance with the official regulation, or are thoroughly suitable for the purpose. If one is conscientious and takes a reasonable amount of pains in preparing a scheme for submitting to the Board's adviser, there is little doubt about its being passed. But there are bold brigand engineers in this country who have erected overhead lines without taking the trouble to acquaint the Board of Trade of their intentions, whose designs contravene most of the clauses in the official regulations, and whose work yet appears to stand solidly and to give satisfaction.

It may be granted that there are numerous cases where overhead lines are being used because it is not commercially possible to run underground, but it should be remembered that the result of American practice with overhead lines in large towns is that they are being put underground as rapidly as possible. In Colonial parts, also, where the current has first passed through overhead wires, the underground system is superseding them. It may be taken as a maxim that for few wires of small section in slightly frequented quarters it may be advisable to run overhead, if the conditions are such as to prohibit the use of underground cables. Where many circuits are required, or in main thoroughfares, underground cables should be laid.

As regards the line itself, notwithstanding periodical suggestions as to the use of cheaper materials than copper, this much abused metal is still the favourite conductor, and is likely to be. Aluminium has not been able to take advantage of the high price of copper, chiefly, it is said, on account of scarcity of water at Foyers.

Continuously insulating or covering overhead wires appears to be necessary in the neighbourhood of chemical works or factories, where the atmosphere is charged with noxious vapours.

Poles are mostly of wood, and this seems to be the best practice for lines carrying a moderate section of copper. Where cables by the dozen are carried overhead, as in the blast furnace districts, very substantial steel girder structures are built and anchored in mounds of concrete.

Every pole should be closely encased in a sheath of a similar material extending from 2 ft. above ground to 2 ft. below ground, and this sheath should be finished off at its upper end so as to facilite the draining of moisture away from the pole itself. Where girder supports are used the sections should be stiffer at the ground line for this reason. This point is accentuated, as there appears to be little attention paid to it in current practice.

Elaborate staying and strutting precautions for bends are sometimes unnecessary, except for sharp angles or the heavier lines. The tramway engineer merely puts up a heavier pole for curves or ends, and this practice may be followed with wooden poles as with steel ones, providing a section of sufficient stoutness is taken to suit the strain.

2. *Increasing the Current Capacity.*—It depends very much upon circumstances what the safe current density should be. Small cables can be more safely over-run than large ones. Single-conductor cables are less affected than multiple conductor mains. The paper, lead-covered type stands over running best, paper leadless comes next, with rubber and plain bitumen insulation in the order given.

The more fresh air a cable gets the less it is affected, so that a single lead-covered cable laid in a roomy iron pipe will keep cooler than a three-core cable bunched up with a lot of others in the solid system or drawn into a nest of conduits of small diameter and non-radiating material, if they are both run at the same current density.

If a cable is run at a fairly steady load of 100 amperes, eight hours a day, it would be better to use a larger section than for a cable which is occasionally run up to 150 amperes for a short period, but whose normal load is 50 amperes. A large temporary excess of current is not so fatal as a large temporary excess of voltage, but what seems to be but a moderate excess of current long continued is more unhealthy than the same degree of over-voltage.

The Northern Counties have led the way in running cables at a higher current density than is generally considered proper; coal is cheap there, and copper is dear. It should be borne in mind, however, that a current density that will not affect the cable itself may seriously trouble the joints upon it.

3. *Utilising Tramway Wires.*—This has been done in the past with more or less success. Recently, voltage regulators have been put on the market which automatically keep the volts steady, independent of variations in load, and by this means it is convenient to use the trolley wires for distributing current to isolated communities, where it would not pay to run a separate main. An article in the Electrical Review of September 28th, 1906, gives details of the lighting of the village of Whittington, near Chesterfield, by using the tramway wires and a B.T.-H. voltage regulator. The difference in cost with its use is said to be £2,000, and the apparatus regulates within 1 per cent. when full load is thrown on and off.

4. *Unarmoured Cables laid in Ground.*—Now that the price of copper has caused people furiously to think, it has been decided in some quarters to cheapen cables by dispensing with the armouring, and to trust to luck that nothing will happen, when laying mains directly in the ground.

5. *Cables laid through Blocks of Houses, &c.*—It is cheaper to group several services on to one point, or to run distributors through houses, when they are being fed in quantities, than to pay for street excavation, and for lengths of service cable, when feeding from a main in the street. The cost of service jointing is considerably lessened, and such joints as are made are left in a drier situation.

The following is a summary of some details as to local practice upon these points, which have been kindly furnished by the engineers referred to.

Barking.—Mr. Howard supplies artisans' dwellings belonging to the Council by putting one service into each block with a master meter in circuit. Mains run from this through the row of dwellings, a service being tapped off at each house. Tenants are charged: for four lights, 6d. per week; for two lights, 4d. per week. He also supplies property owners at one point in a row, through a master meter at 2½d. per unit, and current is distributed through the block to the various meters of the tenants. For arc lamps, current meters are not used, but hour meters, upon the readings of which the consumer is charged.

Bury.—Mr. Watson supplies blocks of offices and pairs of houses from one service. He has also erected overhead three-wire mains in a suburban district, and will extend when opportunity offers.

Chester.—Mr. Britton feeds blocks of cottages by running a distributor through them.

Glasgow.—Mr. Lackie has avoided service jointing in special cases by looping distributors in from the street when laying the cable, and considers it a cheaper method. In Scotland, workmen live in tenements three and four stories high, so that one service will supply six or eight customers.

Rochdale.—Mr. Atchison runs motors off tram circuits on the understanding that current is off at night and intermittently when necessary. He has supplied "in bulk" to landlords in the district, who from a single service run insulated wires on insulators through the false roofs or cellars of blocks to their tenants' meters.

Shoreditch.—Mr. Russell supplies model dwellings, at which current is switched on from dusk to midnight, and from October to March inclusive from 5 am. until daylight. Tenants are charged 8d. a week for two rooms and 10d. for three rooms.

Stretford.—Mr. Rowland feeds blocks of houses in side streets by running a distributor through them, underneath the joists of the ground floor.

The Trafford Park Co. feeds blocks of houses by running a distributor through them inside the false roof. The cable is brought up the end wall in gas barrel, with a switch fuse, about 10 ft. high, in locked case. The meters are of the token type, worked by copper deposition, and tokens are purchased only from the company.

Wigan.—Mr. Slevin, in the Pemberton district, has colliers' cottages wired on the insulating clip system, with which he has had no trouble. He charges from 8d. per week for four lights to 1s. 9d. per week for 18 lights, but it is not a lucrative investment at present.

A certain electric supply company near Manchester ran a service in 1896 through the cellars in 24 shops, from a transformer situated in the middle of the block. The cables were rubber insulated singles in tarred wood casing. There has been no trouble to date, and the arrangement was cheap and brought custom. In connection with an eight-house block served from one transformer service by this company, a 1½-kw. transformer has supplied, at 100 volts, lamps equivalent to 4,800 watts during the last four years without complaints as to pressure or trouble on the transformer.

Cheapened Wiring.—The wiring of houses by clamping insulated wires between porcelain cleats has much to recommend it. The system is largely used on the Continent, and is coming into more general use in the North of England. There appears, however, to be a prejudice against the system in England. The beauty of this cleating arrangement is that the wires can be taken out if necessary; and it may be said to compare with encased wires as overhead wires compare with underground distribution.

Meterless Charging.—The non-use of meters saves in many ways. The meter is a big expense on a small installation. The meter reader does not work for nothing. Meter testing is a nuisance. But it is very clear that consumers without such a restrictive influence often burn their lamps so long as to immolate the profits. In the Ebbw Vale district of South Wales this difficulty appears to have been overcome by the consultant, Mr. R. P. Wilson, who has installed sealable holders for lamps, and charges 1s. 2d. each for lamp replacements, with a rate of 8s. per 8-c.p. lamp per annum. Mr. Wilson's opinion is that this system, by saving the cost of a meter, is of value with two or three-light customers, who by their quantity are a profitable class in some districts. It is conceivable that the consumer will appreciate that the sooner he burns his lamp out, or dims it by excessive use, the sooner will he have to pay for a new lamp. The sealing-lug in this lamp is fixed in place of one of the pins at the side of the usual bayonet lamp-plug.

Foreign Practice.—In large towns both feeders and distributors are armoured cables laid directly in the ground, but if the soil is impure (due to the barbarous use of the gutters for sewage conveyance) the trench is partly filled with sand, and the cables are laid in this. Creosoted planks are sometimes placed over these mains, and Dr. Kapp used rolled steel covers with satisfaction in his practice. Overhead mains are the exception in Germany, except in the smaller towns, but in Switzerland mains are frequently carried overhead, both for H.T. and L.T. Swiss H.T. systems are sometimes carried on masts of concrete, which look heavy, but won't wear out. A peculiar German practice is to use a couple of armoured cables for the outers, and a bare copper cable for the neutral of a three-wire system, all laid direct.

In Italy, as mentioned by Mr. Fedden in his recent M.E.A. paper, it is the practice to run distributors on insulators attached to short wooden posts, which are supported by means of iron brackets fixed to the upper parts of the houses.

I have discussed the subject of cheapened distribution with several central station engineers, whose opinions agree as to the comparative waste of time and energy involved in hunting after the small consumer of light. Under the usual conditions the game is hardly considered by them to be worth the candle. Such irritating work should devolve upon someone specially capable, whose salary would be more than repaid by the impression he makes on the load curve.

The Newcastle Electric Supply Co.'s motto appears to be summed up as: "Lay the main to get the consumers"; as a consequence, almost every street is blessed with the presence of electric mains, and this plucky policy must help the output considerably.

Discussion.

The Chairman (Mr. T. L. Miller) said that in the case of distribution mains for lighting and power the current capacity of the mains could not be increased very much because of the Board of Trade regulations. When the tramway system was first started in Liverpool, motors were supplied off the traction feeders, and there was a large works at Atherton supplied in the same manner. The charges for meters in many districts bore very heavily on the small consumer, and he agreed with the author that these charges should be done away with. The small consumer was a valuable one, as he generally had all his lamps in use, whereas in a large house only a portion were on. He mentioned a case where a builder wired some 300 houses. Arrangements were made to supply him in bulk, and he charged the tenants. A tramway pillar was fitted with a meter and maximum-demand indicator; from there cables were laid down streets and looped into each house.

Mr. Morshead, as a cable maker, was an advocate of overhead mains in the poorer districts, as he considered it would eventually lead to laying an underground distributor later on. The cost of an overhead main was about one-third the cost of one underground, and the reason that overhead mains were being replaced by underground, was that the former were too small for the work. There was a considerable amount of overhead work going on in the Middlesbrough district. In America wooden pins were taking the place of iron bolts for insulators. The lighting of Whittington referred to in the paper was from the feeder pillar, and was working satisfactorily. Some seven or eight years ago jute-covered unarmoured cables were laid direct in the ground in Leith, and had given no trouble. He thought unarmoured cables were very good for general use.

Mr. Chamen said he believed that in time all cables would be overhead owing to all the room being taken up in the street. There were places where a piece of string could not be laid, and an overhead wire could be tapped where the street could not be taken up. With regard to meterless charging, he was afraid there was no other way than charging the landlord. The working man was a good consumer, as he generally burned his lamps a long time. He thought the motto for main laying should be "Find the consumer first, and lay the main afterwards."

Mr. S. J. Watson said that cable laying was very costly; it did not compare at all with the cost of a small lead pipe for water and wrought-iron pipe for gas. The author had not mentioned anything about laying bare cables in conduit, a system which he believed was being used to a great extent; on a three-wire system of some size, say, 0·5—0·2—0·5 sq. in., it was possible to save some 3s. or 4s. per yard by that method. The overhead line in Bury referred to in the paper was about 800 yards in length, and was put up to supply two large houses; to supply them underground was commercially impossible. The poles were 7 in. diam. at top, and 10 in. at bottom, and 31 ft. long, there being about 6 ft. in the ground bedded in concrete. The outers were at the top, and the middle wire split at the bottom. The cost of laying a main of that description—say, No. 2 S.W.G. outers—was about £300 per mile against £800 for a solid or draw-in system, a saving of £500 per mile. Another advantage of the overhead system was that if the section of copper had to be increased or the line had to be discarded nearly all the material could be recovered. He did not think it was possible to increase the current capacity of mains very much, owing to the regulation pressure drop, nor did he think it advisable to connect to the trolley wire, but rather to the feeders, and even then the troubles of the trolley wire would be felt to some extent. Unarmoured

cable laid direct would not be used very much, and should be protected in some manner. To lay it in made-up ground would shorten its life very much. The revenue derived from supplying offices and small dwellings did not warrant spending money on a separate service for each.

Mr. WHEELWRIGHT asked how the consumers who were supplied from trolley wires or traction feeders were charged, and whether the Corporation received payment twice over—viz., from tramways department and consumer.

Mr. C. C. ATCHISON said it was easier to connect to the trolley wire than the feeder, and one did not always want to break up the street. He did not supply lighting from trolley wires on any account. There was a difficulty in finding room for cables in some streets, but perhaps, in the future, the gas mains would be taken out, and leave room for the cables. He would not like to risk unarmoured cable without some protection.

Mr. H. W. WILSON said he had had experience in laying bare cables in conduit; it had to be carefully done and supervised. Aluminium was good for this class of work. He thought that the people who advocated aluminium strongly were those who had not used it. On an estate where there were 700 houses supplied by the landlord, overhead mains were run down the backs of the houses, and a weekly charge was made. A cut-out was fitted which came into action when more than six lamps were on at one time, and the consumer had to send round to the landlord to have it put in again. Overhead mains for outlying districts were inevitable.

Mr. C. E. KNOWLES said he had charge of about a mile of overhead mains at Glossop, supplying motors for quarry purposes at 480 volts. They gave no trouble.

Mr. J. FRITH asked if there was any likelihood of getting a lamp of higher voltage than the 250-volt incandescent lamp.

Mr. J. H. C. BROOKING, in replying to the discussion, said he did not think overhead mains would ever be used in large towns. They were generally used for outlying distributors. His experience of bare copper in ducts had not been a very happy one. Some protection was necessary for poles at the ground level from the action of the soil, and atmosphere, and for other reasons. Recently he saw some aluminium tee-joints, which looked a very good job until they were handled, when they came away from the soldering material.

Some Phenomena of Commutation.

By Prof. F. G. BAILY, M.A., and W. S. H. CLEGHORNE, B.Sc.

At a meeting of the Glasgow Section of the INSTITUTION OF ELECTRICAL ENGINEERS, on December 11th, Mr. W. W. LACKIE in the chair, a discussion took place on the above paper, which was read at the previous meeting, and was abstracted in our last issue.

In opening the discussion, the CHAIRMAN said that it was commonly supposed that the ohmic resistance of carbon, such as was used for street-lighting purposes, decreased with the rise in temperature. In the laboratory under his charge they had carried out some tests which went to show that the resistance of carbon as usually supplied for arc lamps was constant up to a red heat. The speeds of the commutators on the machines in use in the Port Dundas Electricity Works agreed with those given in Prof. Baily's paper. The 500-KW. machine had a speed of 1,700 ft. per min., and the 1,500-KW. machine had a commutator speed of 3,000 ft. per min. The D.C. turbo-generator in the St. Andrew's Cross Works had a speed of 8,000 ft. per min. The pressure of the brushes on the commutator varied from 30 oz. to 50 oz. with carbon brushes, but was as high as 73 oz. per sq. in. with copper brushes. A common article in use in the Corporation's generating stations was the ordinary paraffin wax candle for lubricating the commutator. The indiscriminate use of commutating poles was undoubtedly wrong.

Mr. HENRY A. MAVOR said that Prof. Baily's conclusions were fully justified by his experiments, and the hypotheses which he had laid down were quite as fully established by practical experience. It had long been evident to most of them that the empirical calculations of voltage and other things had only an indirect bearing on sparkless commutation. If they designed their machines with everything that could be desired in the way of satisfactory calculations as to the reactive voltage, they would sometimes find a machine which was quite unworkable. Most of them had different limits for the reactive voltage for small machines and for large ones. Now if the reactive voltage were the main thing to safeguard, it was difficult to understand why they could work safely with a reactive voltage as high as 8 on a large machine, while it was not safe to exceed 2 on a small machine. Vibration might arise from many causes—from the commutator being out of true running, or made of unsuitable metal. That was a conclusion which he had recently come to from the fact that they had a general superstition now against making commutators of any cast metal because of the risk of the impurities rendering the friction inconstant and uncertain. Friction in itself was not a very serious matter, but it produced vibration and brought about very uncertain results. Having got a commutator of a homogeneous metal whose properties were known, and could therefore be dealt with by means of a suitable brush, they were again face to face with the condition of the surface of that material, and they were aware now that a hard-drawn pure copper commutator with suitable surface might become very troublesome in the presence of certain matters which might accumulate whether it was running or at rest. For example, the dust of textile fabrics was most injurious to the running of a commutator. He desired to get back from the carbon brush to the copper brush. When they could see a machine that had been in use for 20 years with copper brushes, subjected to changing loads and other vicissitudes, with the commutator in perfect condition, there did not seem any essential reason why they should incur the loss due to the use of a carbon brush.

Mr. W. B. SAYERS said that he had experimented with the means of obtaining sparkless commutation with fixed brushes and various devices, and he had met with a certain amount of success in that direction. When the carbon brush came into the field, it seemed to do very easily what they had found a troublesome and difficult thing. However, it was clear that the carbon brush was not the complete solution of the matter, as they saw now all kinds of commutating poles and devices being introduced, which were said, at the time he spoke of, to be quite unnecessary.

Mr. MORRISON said that with regard to paraffin wax, great care should be taken to see that the commutator was not too hot when the wax was put on, or it would disappear immediately, and would have no effect. Again, if the commutator was too cool, the melting point of the wax would be higher than the temperature of the commutator itself, the contact resistance would be very high, and the wax would get into a sticky condition, and make the brushes jam.

Mr. KELSO asked why the experiments were not carried beyond 60 amperes per sq. in.?

Dr. J. T. BOTTOMLEY, in a written communication, said he wished that the experiments had been more judiciously planned. The pressures were said to range from 7 oz. to 46 oz., but the numbers chosen were 7, 12, 18 and 46. He could think of no relation between these numbers, and if they looked at the curves, they were spaced so irregularly and in so peculiar a manner, that one could scarcely help thinking that there must be some factor concerned in the result which was not being taken into account. The speeds, too, chosen for experimenting had no simple relation with each other. In spite of the great difficulties of the inquiry, the authors had obtained results which were wonderfully concordant. The authors referred to the curve in the paper, representing the values of e/i where e was the E.M.F. and i the current; and the "curious form" of this curve was commented on. Looking, however, at the points which showed the ascertained values of the ratio, it seemed to him that there was no justification for making this curve a curve of wave form (curve with two contrary flexures). A nearly straight line or a flat arc of a circle would pass as closely through these points as did the curve which the authors had drawn. The curvature also to the left side in this figure was much too great. The results obtained with lubricated brushes were highly interesting. It was not, perhaps, quite generally known that even in the case of the plugs of a resistance box, the resistance at the plugs was markedly reduced if the plugs were thinly smeared with light paraffin oil. Probably, the paraffin helped to clean away the film of oxide which invariably covered the brass surfaces, no matter what trouble was taken to remove it. Also the film of paraffin was more easily pressed aside from between the brass surfaces which came in contact than a corresponding film of air. In any case, the result was certain. At the same time he must say that his experience was altogether against lubricated brushes. The copper or other metal of the commutator segments did not, and could not, wear down exactly the same as the mica which insulated the segments, and the mica got wetted with the lubricant. The particles of metal or carbon from the brushes tended to stick to the mica instead of being blown away, as was the case when the surface of the commutator was quite dry, and a tendency to spark was the invariable result.

Mr. CLEGHORNE referred to the statement that the leading edge of the brush should be of low resistance, and the trailing edge of high resistance. While that was quite feasible in a fixed machine, in the case of reversible machines, such as they had in tramcar work and the like, it would be interesting to know how the composite brush would work with a central core of high-conductivity copper and laminations on either side of high-resistance carbon.

Prof. BAILY also spoke in reply to some of the points raised.

The Heating Coefficient of Magnet Coils.

By G. A. LISTER, B.Sc.

This paper was read before the Birmingham Section of the INSTITUTION OF ELECTRICAL ENGINEERS, and was abstracted in our last issue.

Mr. HENRY LEA, who opened the discussion, gave some interesting figures relating to the radiating properties of iron pipes, a subject closely connected with that of the paper. He found that 1 sq. ft. of hot iron would dissipate 2·14 B.TH.U. per hour per 1° F. difference of temperature. Taking 70° F. (39° C.) as the temperature rise, which was the figure he always specified, he showed that 20·9 sq. cm. of such surface were required to dissipate 1 watt, and that the corresponding heating coefficient was $20{\cdot}9 \times 39 = 815$. So high a temperature rise as 50° C. (90° F.) at full load would leave no margin for overload.

Mr. A. M. TAYLOR thought that the measurement of the temperature rise of field coils by means of increase of resistance would soon be adopted here. The coefficient fell as the temperature increased. This might be due to convection effects, which would tend to increase with the increase of temperature. With regard to the stationary coils of large A.C. generators, he had been much interested in the question as to how the temperature rose when the peak load came on, the generator having been running under, say, normal full load conditions for some time previously. Designers would soon have to meet a demand for a generator to give 100 per cent. overload during the short period of peak load.

Mr. ORSETTICH said that proper consideration of ventilation should enable the designer to save a considerable amount of copper in the case of high-speed machines. He worked with the outside surface only, and by obtaining the coefficient for each type of machine, and plotting against speed, he took into account the ventilation of the machine.

Mr. LEO. MURPHY thought that the slight differences in air and in the core could be varied and even inverted by using different formers and different fits over the core. He would like to know the colour of the coils tested.

Dr. R. T. GLAZEBROOK, in a written communication, said that the general result of Mr. Lister's interesting paper seemed to be that there was no such constant as the heating coefficient, as he defined it. The simplest assumption one could make for the amount of heat lost by radiation from a surface element s which was at a temperature $t°$ above its surroundings was that the loss per second was $h\,t\,s$, where h was the radiation constant, or exterior conductivity.

Assuming that h was a constant over the whole surface, then the total loss per second $= \int h\,t\,ds = h\,s\,\bar{t}_s$ when $\bar{t}_s$ was the mean excess of temperature over the surroundings of the surface layers, not of the whole coil. If the temperature was steady then the total loss must be equal to the watts expended; thus they had—

$$\text{Watts} = h\,s\,t_s \text{ or } \frac{1}{h} = \frac{s}{\text{watts}}\,t_s = s_w \cdot t_s,$$

using Mr. Lister's notation. Thus $\frac{1}{h}$ corresponded to his c_h, the heating constant, but the temperature in the equation was not the mean temperature of the coil, which was measured by the change in resistance, but the mean temperature of the surface of the coil, which was quite different. If there were a constant ratio between these two mean temperatures, then the law given in the paper would follow, but he thought Mr. Rayner's curves showed that there was no such constant ratio. Again, he felt sure it was a mistake to assume that the coefficient was the same for all the surfaces of the coil. In the discussion on Mr. Rayner's paper (*Journal* I.E.E., Vol. 34, p. 711), he had shown how values for both the interior conductivity k, and the exterior conductivities, or radiation constants, h_1, h_2 of the coils might be found—h_1 relating to the outer surface, and h_2 to that in contact with the core. The two quantities differed notably, h_1 being of the order of $\frac{1}{2}\,h_1$, so that it was impossible to determine the mean rise of temperature from a knowledge of the surface and the watts by means of a single coefficient.

As he had already said, the $\frac{1}{h}$ of his formula was the c_h, or heating constant, defined, however, with reference to the mean rise of surface temperature, but in comparing the actual numbers it must be remembered that his h related to a square inch, while Mr. Lister's c_h referred to a square centimetre. What could be done possibly, was to obtain by careful experiment the values of k, h_1 and h_2 for coils similar in design and material to those which were to be used, and to base calculations applicable only to such similar coils on these figures.

Dr. ALFRED HAY (written communication) said the relative importance of the parts played by radiation, convection and conduction still seemed to be obscure, but from Mr. Lister's experiments it would appear that conduction and convection were quite as effective in producing cooling as radiation. The marked influence of good ventilation pointed to the fact that convection was an extremely important factor. In the case of a coil freely exposed to the air over its entire surface, the radiation effect could, to some extent, be differentiated from the convection effect by certain experiments which he proposed.

Mr. H. M. HOBART wrote pointing out that in the figure 1,500 quoted by Goldschmidt, the *whole* surface of the coil was taken as cooling surface, and the rise was taken by resistance measurement. Reckoning this figure on the *external* cylindrical surface of the coil would reduce its value to about 600. The rise by resistance measurement might be taken as 1·65 times the thermometrically determined temperature rise at the outer surface of the coil, and thus the value 600 would be further reduced to 364. This value was in good agreement with the value 365 given by Esson, and was also, with due regard to the numerous factors which influenced the heating, in fair agreement with Neu and Levine's value of 720 by resistance measurement, which reduced to $\frac{720}{1{\cdot}65} = 435$. In the year 1898, Mr. R. C. Clinker, at his request, made a comprehensive series of tests concerning the thermal occurrences in field spools. In the accompanying figure he had arranged a few of Mr. Clinker's results in a form which brought out the bearing of the peripheral speed of the armature upon the temperature rise of the field spool, and also showed the way in which the temperature rise varied at different parts of the coil. They saw from this figure that when the armature was at rest the layer next to the magnet core, and the outside layer, had practically the same temperature, but that when the armature was running at a peripheral speed of 10 metres per second, the outer layer had a much lower temperature than the layer next the magnet core. It was very important to avoid taking the results of tests on a single spool as guidance for other cases. According as a spool was completely bound up in insulating materials or left exposed on all sides to air, the temperature rise and the temperature distribution became greatly modified. In a general way, however, Rayner's later tests, in which he obtained a ratio of maximum to mean temperature of about 1·15, confirmed fairly well the results of Clinker's 1898 tests. Another very exhaustive series of tests were those made by Dettmar in 1900 on the effect of temperature on cotton coverings. These tests showed that in the course of time at emperature of less than 100° C. caused decided deterioration. The more recent tests of the National Physical Laboratory on large numbers of insulating materials, showed that with all these materials deterioration set in at a temperature of not over 125° C., and in most cases the temperature at which deterioration occurred was considerably below 125° C. With a knowledge of these results it was certainly undesirable that the highest temperature existing in any part of a coil wound with cotton-covered wire, should be much over 100° C. If the hottest part of the coil was at a temperature of 105° C., the mean temperature, as determined by resistance measurements, would be about 90° C. Taking the temperature of the surrounding air as 30° C., it was evident that the temperature rise as determined by resistance measurements should not be more than 60° C. Mr.

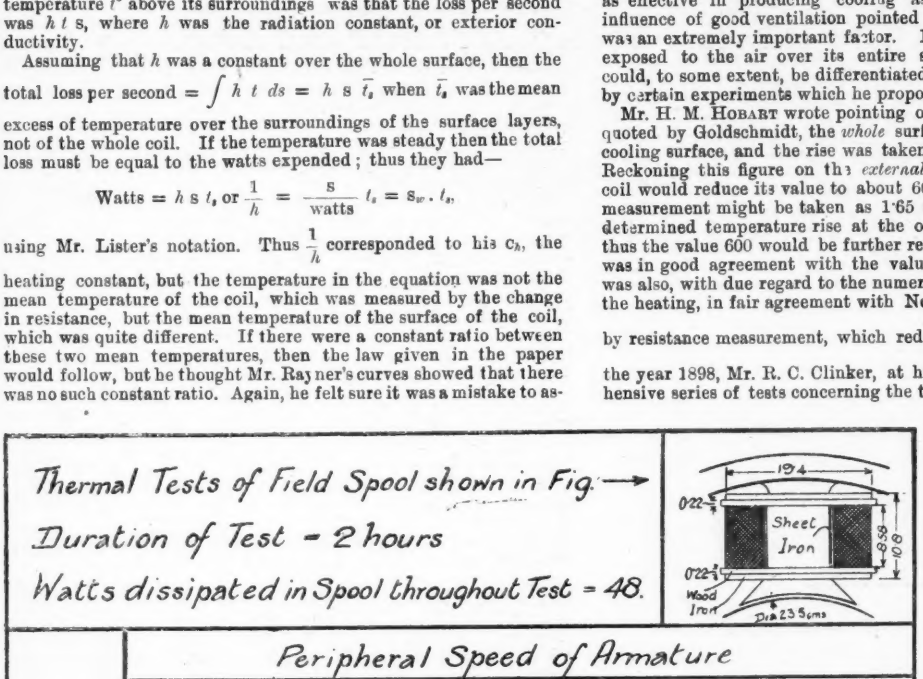

Thermal Tests of Field Spool shown in Fig.
Duration of Test - 2 hours
Watts dissipated in Spool throughout Test = 48.
Sheet Iron
Wood
Iron
Peripheral Speed of Armature
0 Metres per Second
10 Metres per Second
Nature of Test
Rate of Increase of Temperature during Tests
Distribution of Temperature at End of Test.
Rise of Temperature by Resistance
Midway
Next Core
Outside
Minutes
Mean rise of Temperature by Res's 37°
Ratio of Maximum to Mean - 1·13
Mean Rise of Temp by Resistance · 37°
Ratio of Maximum to Mean - 1·15
Inner Coils
Outer Coils
Position of Layers

FIGURE REFERRED TO IN MR. HOBART'S COMMUNICATION.

Clinker's tests, and also the subsequent tests made by the National Physical Laboratory, showed that in many cases the temperature rise as determined by resistance measurements, exceeded by more than 60 per cent. the rise as determined thermometrically. Thus the thermometrically-determined rise should not be permitted to exceed 37½° C, and it was evidently not advisable to raise the present customary permissible temperature rise of 45° C. but rather to reduce this. Allusion was made in the paper to a coil in which the cotton coverings of the wires were impregnated with a certain material which resulted in a decreased temperature rise. He believed that the first earnest attempt to develop and properly apply such materials was made by H. W. Turner, about the year 1901. It had been difficult to demonstrate the effectiveness of such a material as regards decreasing the temperature rise, owing to the fact that it tended to make all parts of the coil assume a more nearly uniform temperature, *i.e.*, when such a material was used, the mean temperature as determined by resistance exceeded by a smaller amount the thermometric temperature than would otherwise be the case. For these and other reasons he was strongly in favour of the introduction of the practice of determining the temperature rise by resistance measurements, instead of by thermometer. Were this practiced generally, a temperature rise of 50° C. above the surrounding air would be thoroughly conservative, but so long as the temperatures were determined by thermometer a "nominal" temperature rise of from 40° to 45° above surrounding air was already rather higher than it was desirable to permit. The trouble was that no individual engineer could introduce such a comparatively new practice as that of invariably expressing the temperature rise of field spools in terms of the result of resistance measurements. Should any designing engineer attempt to do this, he would bring upon himself the charge of employing higher temperatures than other designers, whereas he might actually be working to lower temperatures. This was only one instance among many others which rendered it highly desirable that the issuing of standardisation rules for temperature rise should not be further delayed. It was very difficult to generalise as to values for the temperature rise per watt per sq. cm. of radiating surface. The influence exerted by the rotating armature on the temperature of the field spool depended very greatly upon the means adopted to ventilate the armature, and upon the consequent amount and temperature of the air passing from the armature to the field. The use of interpoles was decidedly disadvantageous from the thermal standpoint, for they obstructed the emission of heat from the field spools, and introduced an additional considerable loss through the heat generated in their own windings. In general, the cooling would be more effective the greater the polar pitch at the air-gap, but there were also, of course, a great many other factors influencing the result.

Mr. E. H. RAYNER, in a written communication, said that when attempting to find some basis which would indicate the efficiency with which field coils of very different patterns would radiate heat, it seemed to him that the temperature which would be attained if unit quantity of energy were dissipated from unit area of the coil per second, was the best indication of this useful quality. For various reasons he took the external area plus the flanges as being the radiating area. However, he thought, with the author, that the total area, including the surface next to the core, might well be included. With this limitation, and using inches instead of centimetres, the two columns 20 and 22, page 655, of his paper gave the heating coefficients as defined by Mr. Lister, except that column 20 gave the results using the maximum internal temperature instead of the mean temperature which was used in column 22. This constant for shunt coils varied from 100 to 250, or in Mr. Lister's units $(2\ 54)^2$, 650 to 1,600, so that the figures on page 16 of the paper referring to open type machines to which his experiments referred—namely, 1,250 and 1,500 for 50 and 500 KW.—were on the safe side. These factors must be used very carefully in any given case, and until information was obtained from any build of coil it was not wise to trust such coefficients obtained from other and dissimilar coils except as very rough approximations. What he would especially draw attention to was the low value given above—650 as compared with 1,600 the upper limit. It must be remembered that these values were obtained on running machines, and, as it happened, of a similar size, 500 KW. A proper consideration of the design of field coils, from a radiative point of view, as well as from a consideration of the ampere-turns required, might lead to a saving of several hundredweight of copper in large machines. He had been assured that, in the case of the manufacture of small machines, this aspect of the subject had enabled such economies to be made in field copper as to convert a commercial loss into a profit. This emphasised the importance of any paper on the subject, and he would advise designers to see that they were not using unnecessarily too much covering, of poor heat conductivity, on their coils.

Mr. ALEXANDER RUSSELL, in a written communication, said that he thought the term "heating coefficient" was not a good one. He would suggest the word "emissivity" on the analogy of "surface emissivity" in heat. Theoretically, it would be better to take the temperature of the outside of the coil instead of its mean temperature, but the accurate measurement of the outside temperature was very difficult in most practical cases. The question arose—did this emissivity vary much with the temperature? Mr. Lister had drawn a curve showing how the watts radiated per square centimetre varied with the temperature rise for a coil supported in air. If w denoted the watts radiated, s the surface, and t the mean temperature rise, the equation to the curve was $w/s = (0{\cdot}6 + 0{\cdot}0016t)\ t/1000$, and for small values of t the "emissivity" might be taken equal to 0·0006 watt per square centimetre per degree difference of temperature. For $t = 50°$ C. the "emissivity" would be about 13 per cent. greater. In this country they generally assumed in commercial testing that $a = 0{\cdot}00428$, but in America they take $a = 0{\cdot}0042$. The calculated temperature of the coil was, therefore, 2 per cent. better in America.

Mr. C. F. SMITH (in a written communication) said that with regard to the cooling effect of the surface of the coil which was next to the iron, it seemed that a good deal of uncertainty still existed as to the relation between the effectiveness of the conducting power of the iron, and the radiating power of the surfaces exposed to air. From actual measurements it would appear as if the metal former was far more effective in promoting the cooling of the coil, when so arranged as to leave an air-space between itself and the pole. The ventilation thereby produced appeared to be far more effective as a cooling agent than the increased heat-conductivity due to metal-to-metal contact between the former and the pole. One difficulty in deciding absolutely on a heating coefficient, which could be applied to coils of all forms, was the variation in the ratio maximum temperature: mean temperature. In Mr. Rayner's values, there was an extreme variation of about 10 per cent. in this ratio. As pointed out by Mr. Goldschmidt in the discussion following the reading of his paper (*Proceedings* Inst.E.E., Vol. 34, 720), there was a practically constant relation between the differences, mean-external temperature, and maximum-mean temperature. Thus the difference between maximum and outside temperature was practically 50 per cent. higher than the difference between mean and outside temperature. By measurement of the mean and external temperatures, it was thus possible to estimate closely what the maximum temperature inside the coil was. From this point of view it might be well if engineers would record both mean and external temperature rises when testing their machines.

Mr. LISTER, in his reply, emphasised the fact that the figures given on pages 15 and 16 were put forward as a consistent range of approximate values only, and that as stated in the paper reliable accurate figures for working conditions could only be obtained by direct experiment on a particular type of coil and machine, and then applied only to the same type. Mr. Lea's reference to iron pipe was interesting. Iron pipe was probably a better radiator than the surface of a field coil, and it was usually so fixed that it worked under much better conditions. The figure for the heating coefficient of 1,025 (Table III) was obtained on a type of machine, the field coils of which were very favourably placed. The figure of 1,550 referred to the modern multipolar protected type. He agreed with Mr. Taylor that convection might be one of the causes of the falling of the curves; but it was also largely accounted for by Stefan's law of radiation. In reply to Mr. Murphy, all the coils which he had tested were black except coils III and V, which were varnished with shellac. He had been very much interested in Dr. Glazebrook's treatment of the problem. But it had appeared to him that in addition to determining k for each type of coil, it would be necessary to determine the exterior conductivities h_1 and h_2 under all the various conditions of type, speed and load. Three ranges of experimentally determined figures would have to be employed, and he thought that most designers would prefer to use one coefficient only. Dr. Hay's suggested tests should give very valuable data. He was afraid that tests on corrugated coils would not give very practical results. He had not suggested that Esson's 355 should be compared with Goldschmidt's 1,500 on the same basis; in the following paragraph he had given the same reasons for the disagreement as those numerically worked out by Mr. Hobart. Mr. Hobart had shown a very close agreement, but it depended upon the figures taken for the two ratios which had to be used.

LEGAL QUERY COLUMN.

[*Questions addressed to the Editors for insertion in this column should be written on one side of the paper. Free use of fictitious names may be made. Answers are furnished by a barrister-at-law.*]

No. 62.—Electricity Mains.—Proximity to Gas Pipes.

"LEX TERRAE" writes:—"Electric light mains are being laid in the district, three wire direct-current *solid* system, 440 between "outers." The gas authorities (corporation) are trying to demand that no cable shall be laid within 18 in. of their gas mains. We offer to keep 9 in. away, but not more. How do we stand legally?"

*** Provisions relating to the laying of electric mains near gas pipes are contained in the schedule to the Electric Lighting Clauses Act, 1899. It is there provided that an electric lighting company or undertakers providing electricity, requiring to lay mains near gas pipes, must give notice to the gas company and must "conform with such reasonable requirements as may be made by the owners . . . for protecting every pipe." They must not allow any main to touch any pipe unless the main is insulated in the manner approved by the Board of Trade; nor may they allow any main to touch any pipe without the consent of the gas company. Any question or difference which may arise must be determined by arbitration. Having regard to the premises, the question is whether the requirements of the gas company are reasonable or not. The Act specifies no particular distance. It would seem that a distance of 9 in. ought to be sufficient where the mains are well insulated. That, however, is a technical question.

No. 63.—*Private Supply of Electricity.—Wires across Roads.*

"A." writes:—"In a recent issue of the Electrical Review, in the answer to query No. 61, it is stated that, where an electric supply is given by a private company or person, and not under provisional order, such private company or person may, without the consent of the local authorities, carry their mains overhead, provided that they comply with the Board of Trade regulations. The opinion expressed on this point is interesting, not only to myself, but possibly also to many others, and it would add to the interest if the author of the opinion in question would state (*a*) the grounds upon which it is based. In his reply, perhaps he would also give us his opinion as to (*b*) what protection the owners of wires so placed across streets would have against an action by the local authorities for their removal, or the local authority removing the wires themselves, and recovering the expenses of such removal in a summary manner from the undertaker, as is provided under Sec. 14 of the 1882 Act; and further, (*c*) would the owners of the wires in question have any protection against any person or persons removing or cutting them down? (*d*) I think that Sec. 14 of the 1882 Act and Sec. 10 of the Electric Lighting Acts of 1899 together make it clear that no electrical wires are lawfully laid overhead across any street by any person or company unless first of all the consent of the local authority and also that of the Board of Trade have been obtained, and that the owners of wires laid across the street under other conditions, place them there entirely at their own risk."

*** With regard to (*a*) the fact that a private company or person may supply electricity is clear from a consideration of the Electric Lighting Acts, which have no application to such undertakings, unless there is a provisional order or other statutory power. The statement that mains may be carried over streets without the consent of the local authority is generally accurate; but in London the provisions of the London Overhead Wires Act, 1891, and in districts where the Public Health Acts Amendment Act, 1890, has been adopted, the by-laws made under these Acts would have to be complied with. In other districts, unless the local authority happens to own the soil on either side of the street (which it seldom or never does) the person supplying electricity may suspend his wires over the road by agreement with the frontagers, provided, of course, they are not hung so low as to impede the traffic; and subject, of course, to the regulations of the Board of Trade referred to in the answer to query No. 61. As to (*b*) the local authority would have no right whatever under Sec. 14 of the Electric Lighting Act, 1882. As to (*c*) if the wires were cut or interfered with by the local authority or anyone else, the owners could bring an action for injunction and trespass (Finchley Electric Lighting Co. *v.* Finchley U.D.C. (1902) (1 Ch. 866). As to (*d*) the person or company referred to in Sec. 14 of the Act of 1882, is a person or company authorised by Parliament to supply electricity. It does not mean a person supplying electricity on his own account. It may be mentioned that the law relating to the supply of electricity is conveniently summarised in the new edition of "Emden's Building Contracts" (fourth edition, 1906) at page 347, *et seq.*

No. 64.—Patent—Licensee.—Manufacture of Patented Article in Foreign Country where Patent is not Protected.

"X" writes:—"Referring to the communication in your issue of 7th inst. on the subject of "Licences to work Patents," will your contributor say what would be the position of a patentee under the following conditions:—

"The licensee under an English patent obtains an order for the patented article for use in a foreign country where the patent has not been taken out, the order being given and the payment made by the English representative of the foreign user. Can the English patentee claim a royalty from the licensee, if the latter constructs and supplies the article (patented in England) in the country where no patent for it exists?

"To take an instance:—A firm of manufacturers holding a licence for a controller, which is patented in England, obtain an order from a firm of London merchants having a branch house in Russia for such controllers, for use by customers, of theirs in Russia, where no patent has been taken out. Can the manufacture make the said controllers in Russia and supply them for use in that country, without being liable to the English patentee, for royalties upon the articles so manufactured and sold; the order having been given and the payment being eventually made by the London firm of merchants?"

*** The licensee would clearly not be liable in the circumstances. The article in question being unprotected in Russia, any person whatever is free to make it there and sell it there, without payment of royalties; otherwise a patent in a single country would cover the whole world.

No. 65.—*Overhead Wires—Consent of Local Authority.*

"S. C. B." writes:—"I notice in your issue of December 14th, under the "Legal Query" column in reply to "Glasgow," you state that a private company or person can supply electricity without obtaining a provisional order, and that it or he can put up *overhead* wires without obtaining the consent of the local authorities. Are you quite correct as regards this latter point? I think that if further inquiries are made you will find that local authorities have jurisdiction as regards the running of overhead wires as well as laying mains under the streets, although they do not always exercise it."

*** "S. C. B." is referred to Query No. 63, *supra*, and the answers thereto.

No. 66.—Overhead Wires.—Refusal of Corporation to Consent.

"Anxious" writes:—"*Re* your reply No. 61 'Glasgow.' We have a client who is connected both with the Corporation supply and his own generating plant. On the opposite side of the road he has other premises which he wishes to connect. To do this he would have to pass over the road. The local authorities maintain that he has no right to run a wire over the street without their consent; this they refuse to give owing to his coming into competition with their lighting. This seems somewhat in conflict with your reply to 'Glasgow.' Would there be likely to be anything in the provisional order of the Corporation to prevent them carrying the line across the street?"

*** This is an interesting example of the question which so often arises in relation to overhead wires. "Anxious" should procure a copy of the provisional order, and any by-laws under the Public Health Acts Amendment Act, 1890, which are or may be in force in the district. These could be seen at the town clerk's office. If the provisional order is in the ordinary form, it will *not* empower the Corporation to interfere; and the by-laws can at most specify the conditions under which wires may be suspended. The Corporation could not so frame the by-laws as to prohibit the wires being suspended over a street. Unless (*a*) the Corporation have some other statutory power; or (*b*) they own the fee simple of the land on either side of the road (which appears to be unlikely) they cannot interfere. "Anxious" would do well to consult his local solicitor, who will probably be familiar with the Acts and by-laws.

No. 67.—Prepayment Meter.—Error in Meter.—Liability of Consumer.

"Burgh" writes:—"I should be much obliged if you would give me your opinion as to how we stand legally with a prepayment consumer, who, owing to the prepayment part of the meter getting out of order, refuses to pay for the current, which is registered correctly. We have one or two consumers who object to pay for the actual current used, as they maintain that, having prepaid, say, 1s., if they get 2s. worth of current for the same, they are not liable.

"I should be much obliged if you could let me know if a case of this kind has been settled legally, also particulars of the same, as it is advisable to get the matter thrashed out at once, otherwise we shall lose a great deal of money by this means."

*** Unless there is agreement, express or implied, that the reading of the meter register shall be absolute and final as between supply authority and consumer, it would seem that the supply authority may recover the price of electricity provided and consumed. By Sec. 57 of the Electric Lighting (Clauses) Act, 1899 (Sched.), which may be in force in the district, the question whether the meter is correct or not is to be settled by a Board of Trade inspection. Before giving a definite answer on the point, it would be necessary to see the terms of the provisional order and of the consumer's agreement. As the matter appears to be one of importance, "Burgh" should consult the solicitor to the Corporation, who might think it wise to take the necessary steps to enforce the rights of that body.

NEW ELECTRICAL DEVICES, FITTINGS, AND PLANT.

The "Industrial" Wattmeter.

The fact that the power consumed by an alternating-current motor cannot be measured, even roughly, by means of an ammeter is one that has frequently told against the alternating-current motor as compared with its direct-current rival. One of the most widely recognised advantages of electric driving lies in the ease with which the power transmitted can be measured, but in order to

Fig. 1.—The "Industrial" Wattmeter.

secure this advantage in the case of an A.C. plant it has, up to the present, been necessary to employ a costly, and often delicate, wattmeter.

What can be done, however, when the problem is thoroughly taken in hand, is shown by the results obtained by Messrs. Everett, Edgcumbe & Co. with their new "Industrial" watt-

meter. The instrument, which is shown in fig. 1, consists of a carefully designed dynamometer movement, from which all unnecessary metal has been eliminated, and which is fitted in a cast-iron case effectively shielding it from stray magnetic fields. The movement is provided with a pneumatic damper, so that accurate readings can be taken, no matter how much the load may vary. The scale, which is of ample length (6½ in.), is practically even throughout, so that readings can be taken with certainty, even quite low down on the scale. This is a point of no little importance, since it is often desirable to be able to measure the power taken by the motor either when running light or when driving, say, a single line of shafting.

It has, until quite lately, been regarded as heresy to suggest enclosing a wattmeter in a metal case if any accuracy at low power factors is aimed at, the argument rightly being that the metal case acts like a closed secondary winding to the current coils, and so introduces a phase displacement between the main current and the flux produced by it. If the angular displacement so introduced

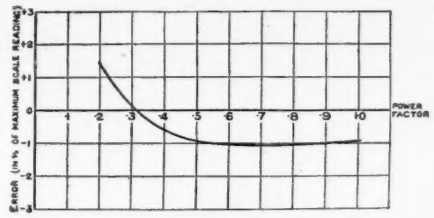


FIG. 2.

be a, then the wattmeter reading, with a lag of ϕ, instead of being $v\,c\cos\phi$ would be $v\,c\cos\phi\cos(\phi - a)$. From this it will be seen that whereas at high power factors the error is of small importance, with low power factors it becomes very considerable. For example, even so small a phase displacement as 1° between current and flux would introduce an error of 3 per cent. with a power factor of ·5, and 6 per cent. with a power factor of ·3, and so on.

In the case of the Everett-Edgcumbe "Industrial" wattmeter, not only is a metal case employed, but actually one of cast-iron. Such, however, is the design of the instrument, we are informed, that the errors due to eddy currents, and also the often greater inaccuracies introduced by self-induction and capacity, have been reduced to a negligible quantity.

That this is so will be gathered from fig. 2, which is reproduced from a curve plotted by the National Physical Laboratory from results there obtained on one of these "Industrial" wattmeters taken from stock. From this curve it will be seen that down to a power-factor of ·2, the error at no point exceeds 1½ per cent. of the maximum reading of the instrument.

Besides being shielded from external magnetic fields, which is of great importance for such work, the instruments are practically dead-beat, and are, moreover, unaffected by frequency or wave-form. To such an extent has this been carried that their accuracy can be at any time checked against direct-current standards, which is, it need hardly be said, of the very greatest assistance in practice.

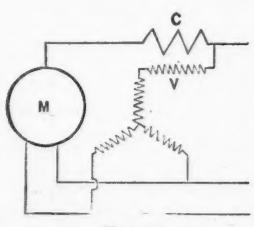


FIG. 3.

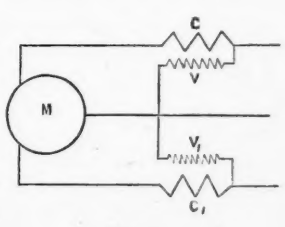


FIG. 4.

The instruments are equally applicable to single, two or three-phase circuits. Fig. 3 shows the connections in the latter case, C representing the series coil, and V the shunt coil, while M shows the load, a motor for example. If the load is an unbalanced one, two separate wattmeters are employed, connected as shown in fig. 4, the total power being obtained, in this case, by adding together the two readings. Moreover, from the ratio of these readings the power-factor of the circuit can be at once found.

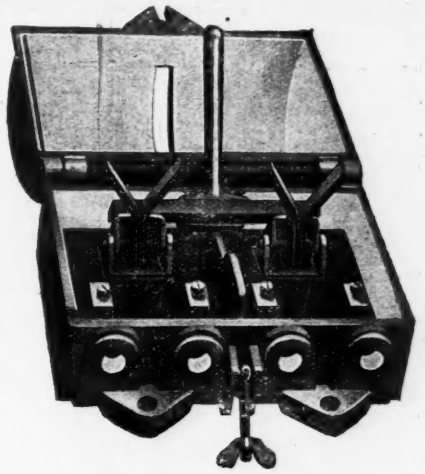
It is interesting to mention also that a wattmeter connected as shown in fig. 3 can be provided with a simple change-over key, by means of which the wattless component of the power can be read off, as well as the true watts. This enables the power factor of the system to be determined, since the ratio of the wattless component to the true watts is equal to the tangent of the angle of lag or lead.

The instruments are constructed for all ranges of current and voltage, and for high-tension circuits are worked off transformers, so designed as to introduce no appreciable error into the readings of the instrument.

Ajax Ironclad Switches.

We illustrate herewith new patterns of their well-known Ajax ironclad switches which are being introduced for 1907 by MESSRS. PARMITER, HOPE & SUGDEN, of Hulme Electrical Works, Manchester.

We understand that many thousands of these switches have been sold during the past year, and the firm's new works have been specially designed and fitted with the latest machinery to enable them to supply a high class of ironclad switchgear at low price.



AJAX IRONCLAD SWITCH.

From January 1st, 1907, the Sloan Electrical Co., 15, Fore Street Avenue, London, E.C., will act as the firm's sole selling agents for London and district. They will stock a large quantity of these ironclad switches of every kind for London district customers.

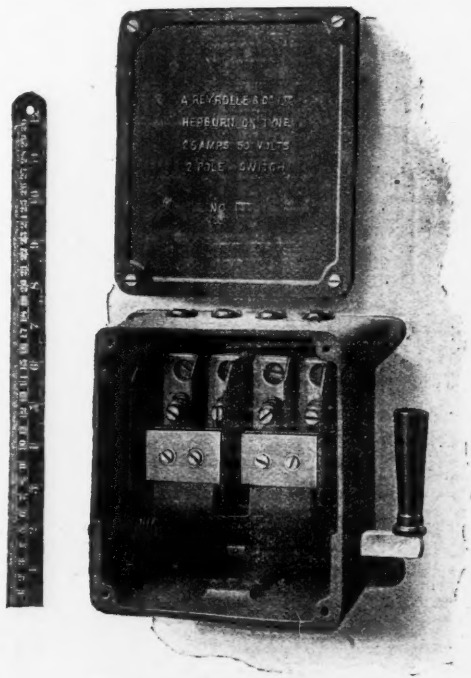
At the Hulme works the switches are turned out now in very large quantities, and they go through the works in lots of 1,000 at a time.

Quick-Grip Spanners.

We understand that MESSRS. SPEAR & JACKSON, LTD., of Sheffield, by arrangement with the Patentees (Messrs. Taylor & Co. of London) are now marketing "Quick-Grip" Spanners as shown in the illustration. This tool has been on the market some little time, but it is stated that it is now to be seriously placed before the trade. While sufficient grip can be obtained to turn almost any nut or pipe, it is claimed to possess an advantage over the spanner that it is immediately adjusted to the correct size, and over the pipe grip that it does not spoil the nuts.

"Reyrolle" Iron-clad Switchgear.

In the accompanying illustration is shown a 25 ampere 500-volt quick-break switch completely enclosed in cast-iron rain-proof case, which is supplied by MESSRS. A. REYROLLE & CO., LTD., of



REYROLLE IRONCLAD SWITCHGEAR.

Hebburn-on-Tyne. The same type of switch is also made for three-phase circuits. Sparking tips are provided to take the arc on breaking. The insulation is very good, the object of the makers being to provide a strong, serviceable article suitable for use in factories, &c.

NEW PATENTS APPLIED FOR.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

28,724. "Improved mechanical ears for carrying overhead transmission cables for electrical traction purposes." H. Oliver. December 17th.

28,739. "Improvements in methods of electric braking." G. H. Babb, F. T. Chapman and E. H. Cockshott. December 17th.

28,758. "Improvements in and relating to incandescent electric lamps," W. Boehm. December 17th.

28,775. "Improvements in the method of and means or apparatus for producing metallic incandescence bodies for electric glow lamps." Deutsche Gasglühlicht Akt.-Ges. (Auergesellschaft). (Date applied for under Patents Act, 1901, March 27th 1906, being date of application in Germany.) December 17th. (Complete.)

28,819. "Electric illuminating apparatus." J. S. Hengler. December 18th.

28,830. "Improvements in electric treadles or rail deflection contact-makers for railway signalling and the like." T. E. Haywood and McKenzie and Holland, Ltd. December 18th.

28,832. "Improvements in electric hoists." J. Richmond & Co., Ltd., and T. Meacock. December 18th.

28,838. "Improved form of door and till electric alarm contact." L. E. Forster and B. Seacombe. December 18th.

28,843. "Improvements in apparatus for electrically igniting miners' safety amps." W. Ackroyd. December 18th.

28,846. "Improvements in electric ignition for internal combustion engines." W. J. Crossley and J. P. Jackson. December 18th.

28,848. "Improved automatic voltage regulator for dynamos." G. S. Neeley. December 18th. (Complete.)

28,849. "Improved automatic regulator for direct-current dynamos." G. S. Neeley. December 18th. (Complete.)

28,865. "Improvements in couplings and fittings for electric conduits and casings, and in the manufacture of the same." J. L. Hanman. December 18th.

28,897. "Improvements in the electro-deposition of iron." S. O. Cowper-Coles. December 18th. (Complete.)

28,922. "Improvements in intercommunication telephones and switches therefor." F. G. Bell. December 18th.

28,959. "Improvements in the method of operating electrical smelting urnaces." A. Hiorth. (Date applied for under Patents Act, 1901, May 5th, 1906, being date of application in Norway.) December 19th. (Complete.)

28,960. "Improved electrical induction furnace with electrodes." A. Hiorth. Date applied for under Patents Act, 1901, June 2nd, 1906, being date of application in Norway.) December 19th. (Complete.)

28,961. "Improvements in the method of operating electrical smelting furnaces." A. Hiorth. (Date applied for under Patents Act, 1901, November 6th, 1906, being date of application in Norway.) December 19th. (Complete.)

28,996. "Improvements in electric arc lamps." H. Beck and Deutsche Beck-Bogenlampen G.m.b.H. December 19th.

29,002. "Improvements in and relating to trolley wheels for electric traction." P. J. Pringle. December 19th.

29,019. "Improvements in or relating to electric induction furnaces." The Grondal Kjellin Co., Ltd., and J. Harden. December 19th. (Complete.)

29,050. "Improvements in or connected with electrical ignition devices for internal combustion engines." A. R. Bellamy. December 20th.

29,072. "Improvements in electrically operated railway and like signals." H. G. Brown. December 20th.

29,086. "Improvements in and relating to exciting Ruhmkorff and other electric coils." Sir O. J. Lodge, Kt. December 20th.

29,110. "Improvements in electrical distribution." U. B. Gilbert. December 20th.

29,113. "Electric bridge hand signal lamp." L. G. Evens. December 20th.

29,120. "Improvements in electric heaters." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 21st.

29,122. "Treating sewage by electrolysis." F. Moir. December 21st.

29,147. "Storage battery." S. Lake. December 21st. (Complete.)

29,148. "Improvements relating to electric motors." W. H. Heath. December 21st.

29,151. "Improvements in or relating to lighting systems for electric railway carriages and trains." Siemens Bros.' Dynamo Works, Ltd., and A. M. Duke. December 21st. (Complete.)

29,172. "Improvements in connection with the electric lighting of railway rains and the like." O. G. A. Frey. December 21st.

29,174. "Improvements in or relating to electric motors." H. Leitner. December 21st.

29,176. "New or improved insulator for electric conductors." A. Boltshauser. December 21st. (Complete.)

29,193. "Improvements in and relating to uni-polar dynamos." W. Mathiesen. December 21st. (Complete.)

29,196. "New or improved electrically operated mechanism for obtaining rotary motion." Sir W. G. Pearce, Bart., and W. R. Reeves. December 21st.

29,201. "Improvements in meters for electricity, gas and the like." Allgemeine Elektrizitats Ges. (Date applied for under Patents Act, 1901, December 28th, 1905, being date of application in Germany.) December 21st. Complete.)

29,202. "Improvements in and relating to the operation of vapour electric lamps." M. Fuss. (Date applied for under Patents Act, 1901, January 11th, 1906, being date of application in Germany.) December 21st. (Complete.)

29,233. "New or improved electrical device controlled by the guard of a train for locking and unlocking railway carriage doors." J. W. T. Cocker. December 22nd.

29,244. "Improved electric torch as used for surgical and dental operations." F. A. Larard & E. L. Dearden. December 22nd.

29,271. "Improvements in electrical furnaces." O. Frick. (Date applied for under Patents Act, 1901, December 27th, 1905, being date of application in Sweden.) December 22nd. (Complete.)

29,276. "Improved telephone apparatus." A. Friedlander. (Date applied for under Patents Act, 1901, September 17th, 1906, being date of application in Germany.) December 22nd. (Complete.)

29,296. "New or improved method of and means for automatically recording telephone calls." H. W. F. Ireland & A. T. M. Thomson. December 22nd. (Complete.)

29,300. "Improvements in the electro-deposition of iron." S. O. Cowper-Coles. December 22nd.

Hipperholme.—The U.D.C. has obtained an extension of the E.L. order, and also power to transfer the order. Negotiations are pending with the Halifax T.C. and the Electrical Distribution of Yorkshire, Ltd., for taking over the order.

PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1905.

Electrical Contact Breakers of Explosion Engines of Motor Vehicles. W. J. Charles and A. Watson. 24,249. November 24th.

Means for Electrically Actuating Intermittently Moving Wheel Work Applicable in Clockwork, Registering and Indicating. W. R. Sykes, F. T. Hollins and F. W. Leake. 24,494. November 27th.

Electrical Control and Propulsion of Vehicles or Trains of Vehicles. J. S. Raworth and A. B. Raworth. 24,810. November 30th.

Trolley Boom Controlling Apparatus for Electric Tramcars and the like Vehicles. S. Hindley. 24,998. December 2nd.

Exhausting of Vacuum Tubes or Vessels for Electric Discharges. O. J. Lodge, A. Muirhead and E. E. Robinson. 25,047A. December 2nd. (Date applied for under Rule 5, Patents Rules 1905, December 2nd, 1905.)

Dynamo-Electric Machines. British Thomson-Houston Co. (General Electric Co.) 26,093. December 14th.

Sparking Plugs for Combustion Engines and the like. H. J. La Force. 26,970. December 27th. (Date applied for under International Convention, May 12th, 1905.)

Electric Arc Lamps Burning Mineralised Carbons. Hegner. 24,882. November 30th.

Vacuum Tubes or Vessels for Electric Discharges. Lodge, Muirhead and Robinson. 25,047.

Apparatus or Devices for Generating Electricity on Motor Cars or Motor Boats. Taylor. 25,353. December 6th.

Method of Controlling the Trolley Poles of Electric Cars and the like. Henshaw and Swindells. 25,415. December 7th.

Magnetic Separator. Simpkin and Ballantyne. 25,718.

Apparatus for Electric Signalling. Brown and Brown. 26,595. December 20th.

1906.

Electric Switches or Circuit Breakers. British Thomson-Houston Co. (General Electric Co.) 932. January 12th.

Electric Branch Switches. J. B. Meiklejohn. 2,286. January 30th.
Electrical Switches. J. A. Kennedy-McGregor. 3,164. February 9th.

Electric Arc Lamps. A. O. Jones and Jandus Arc Lamp & Electric Co. 3,714. February 15th.

Electric Furnaces. C. Bingham. 4,836. February 22nd.

Method of and Apparatus for Detecting Electrical Oscillations. L. H. Walter. 4,585. February 24th.

Shade-Holders for Electric Incandescent Lamps and the like. T. Torda and C. M. Stanger. 4,588.

Production of Electrotypes. S. O. Cowper-Coles. 4,684. February 26th.

Electro-Magnetic Relays. P. O. Pedersen. 7,150. March 24th.

Electrolytic Interrupters and Method of Operating Same. H. Besser and L. Cobe. 7,915. April 2nd.

Manufacture of Arc Light Electrodes Having Metallic Insertions. Gebruder Siemens & Co. 8,656. April 10th. (Date applied for under International Convention, May 31st, 1905.)

Telegraph Poles. R. B. Ransford. (B. Bayly.) 9,115. April 17th.

Adjustable Suspenders for Electrical Devices. A. Berry. 10,703. May 7th. (Date applied for under International Convention, July 11th, 1905.)

Electric Arc Lamps. F. Ruzicka. 11,469. May 16th.

Electric Measuring Instruments. British Thomson-Houston Co. and E. Holden. 514. January 8th.

Electrical Measuring Instruments. S. Z. De Ferranti, M. B. Field, C. C. Garrard and Ferranti, Ltd. 774. January 11th.

Electric Arc Lamps. B. M. Drake, A. D. Jones, P. V. Castell-Evans, and Jandus Arc & Electric Co. 5,856. March 10th.

Telephone Exchange System. W. C. Fairweather. (Kellogg.) 7,998. April 3rd.

Detector for Wireless Telegraphy. W. P. Thompson. (Ges. für drahtlose Telegraphie.) 8,659. April 10th.

Influence Electrical Machines. H. Wommelsdorf. 9,086. April 17th.

Method of, and Furnace Plant for, Reduction of Ores or the like by Electric Transformer Furnaces. O. Frick. 10,997. April 30th.

Methods of Insulating Electric Conductors, Applicable more Particularly for Rheostats, Heaters and the like. British Thomson-Houston Co. (General Electric Co.) 10,208. May 1st.

Brushes of Electric Motors. R. B. Ransford. (Compagnie Parisienne des Voitures Electriques Procedes Krieger.) 14,165. June 20th.

Brackets for Suspending Aerial Electric Cables. J. Gray. 14,403. June 23rd.

Electricity Measuring Instruments. J. Y. Johnson. (Hartmann & Braun, Akt.-Ges.) 18,013. August 10th.

Method of Precipitating Metals Electrolytically. A. Ramen. 18,080. August 11th.

Production of Arcs for the Electrical Treatment of Gases. H. Pauling. 18,599. August 20th.

Alternating Current Commutator Dynamo-Electric Machines. Siemens Schuckertwerke. 19,389. August 30th. (Date applied for under International Convention, August 30th, 1905.)

Bridge Type Fuses and Distributing Boards in Connection with Electrical Work. Howell. 591. January 9th.

Carcases for Dynamo-Electric Machines. F. H. Loring. 605a. January 9th. (Date applied for under Rule 5, Patents Rules, 1905, January 9th, 1906.)

System and Means for Charging Secondary Batteries. McIndoe. 973.

Electric Safety Spark Gap Devices. British Thomson-Houston Co. (Allgemeine Elektricitäts Gesellschaft.) 1,309. January 17th.

Apparatus for Protecting Telegraph and like Lines from the Effects of Lightning Discharges. Fuller and Fuller. 1,914. January 25th.

Sparking Plugs for Electric Ignition in Explosion Engines. Sharpe. 3,402. February 12th.

Regulations of Alternating Current Circuit Subject to Fluctuations of Load. Siemens Bros. & Co. (Siemens Schuckertwerke.) 3,677A. February 14th. (Date applied for under Rule 5, Patents Rules, 1905, February 14th, 1906.)